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**BUREAU OF LABOR STATISTICS**  
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**BUREAU OF LABOR STATISTICS }**

**SAFETY CODE SERIES**

**SAFETY CODES FOR  
THE PREVENTION OF  
DUST EXPLOSIONS**

**NATIONAL FIRE PROTECTION ASSOCIATION AND  
UNITED STATES DEPARTMENT OF AGRICULTURE  
SPONSORS**

**TENTATIVE AMERICAN STANDARD**  
Approved July 2, 1926, by  
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# BULLETIN OF THE U. S. BUREAU OF LABOR STATISTICS

NO. 433

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## 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.

Early 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 present 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.

The committee is constituted as follows:

Name and business affiliation	Organization represented	A. E. S. O. Classification
J. M. Sandel, Department of Labor and Industry, Harrisburg, Pa.	Association of Governmental Labor Officials of the United States and Canada.	Governmental, regulatory.
John Roach, Deputy Commissioner of Labor, Trenton, N. J.	International Association of Industrial Accident Boards and Commissions.	Do.
F. C. Allen, Jr., Allen & Billmyre, New York City..	Dust Collection Equipment Manufacturing Group.	Manufacturer.
S. E. Phillips, Spencer Turbine Co., Hartford, Conn.	do.....	Do.
G. F. Butt, John F. Metcalf Co., Chicago, Ill.....	Grain Elevator Construction.....	Do.
Walter D. Archibald, Archibald & Lewis, New York City.	American Spice Trade Association.	Employer.
C. J. Alger, Corn Products Refining Co., Chicago, Ill.	Associated Corn Products Manufacturers.	Do.
E. B. Ricketts, New York Edison Co., Irving Place and Fifteenth Street, New York, N. Y.	National Electric Light Association.	Do.
B. S. Mace, Baltimore & Ohio R. R., Baltimore, Md.	Railway Fire Protection Association.	Do.
G. F. Ewe, Van Dusen-Harrington Co., Minneapolis, Minn.	Terminal Grain Elevator Merchants' Association.	Do.
P. J. Conlon, International Association of Machinists, 706 Machinists Building, Washington, D. C.	U. S. Department of Labor.....	Employee.
Robert Palm, Consulting Engineer, 59 Fairview Avenue, Verona, N. J.	Sugar industry.....	Qualified specialist.
A. H. Nuckolls, Underwriters' Laboratories, 207 East Ohio Street, Chicago, Ill.	Underwriters' Laboratories.....	Do.
David J. Price, Chairman, U. S. Bureau of Chemistry, Washington, D. C.	U. S. Department of Agriculture..	Do.
H. A. Burnham, Associated Factory Mutual Fire Insurance Companies, Boston, Mass.	Associated Factory Mutual Fire Insurance Companies.	Insurance representative.
Eugene Arms, Mutual Fire Prevention Bureau, 230 East Ohio Street, Chicago, Ill.	Mutual Fire Prevention Bureau..	Do.
H. E. Newell, National Board of Fire Underwriters, 85 John Street, New York, N. Y.	National Board of Fire Underwriters.	Do.
L. A. De Blois, National Bureau of Casualty and Surety Underwriters, 120 West Forty-second Street, New York City.	National Bureau of Casualty and Surety Underwriters.	Do.
Joseph G. Hubbell, National Inspection Co., 223 West Jackson Boulevard, Chicago, Ill.	Underwriters' Grain Association..	Do.

### NATIONAL FIRE PROTECTION ASSOCIATION

The National Fire Protection Association, with offices at 40 Central Street, Boston, Mass., was organized in 1895 "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 30 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

The United States Bureau of Chemistry, 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 cooperates with the National Fire Protection Association in the work of the dust explosion hazards committee, of which David J. Price, engineer in charge of development work in the Bureau of Chemistry, is chairman. The regulations prepared by this committee, and published in the bulletin, embody the control measures developed in the Bureau of Chemistry 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, 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.

## **SAFETY CODE FOR THE PREVENTION OF DUST EXPLOSIONS IN STARCH FACTORIES**

### **Introduction.**

1. Many factories make wet starch only for subsequent conversion to sugar or syrup; 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 Regulations for the Prevention of Dust Explosions in Terminal Grain Elevators, issued by the National Fire Protection Association. (See p. 12.)

4. As to gluten and feed departments, arrangements shall conform to the Regulations of the National Fire Protection Association for the Prevention of Dust Explosions in Flour and Feed Mills. (See p. 9.)

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.

This code applies only to buildings erected subsequent to the adoption of these regulations.

The word "shall" where used shall be understood as mandatory.

The word "should" shall be understood as advisory.

The word "may" shall be understood as permissive.

### **10. 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, (c), (d), and (e), 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. Building should not be more than three stories above the basement in height.

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.

15. All walls shall be finished smooth and irregularities of contour brought flush with the surface, or filled so as 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.

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

## 20. 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 the Installation of Blower and Exhaust Systems.<sup>1</sup>)

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.

<sup>1</sup> Obtainable from National Fire Protection Association, 40 Central Street, Boston, Mass.

**30. Dry starch grinding and grading.**

31. 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 projection edge faced downward.

33. All starch before milling shall pass a one-half 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 nonsparking 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.

**40. 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.

**50. 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 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.

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.

**60. The 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.

**70. 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.

**80. 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 regulations of the National Electrical Code<sup>1</sup> for electrical devices in dusty locations. All electrical devices, whether switches, fuses, cut-outs, or motors, which flash or spark when operating, shall be located outside or cut off from dusty departments, or be of such type and construction, that the flash or sparks may not come in contact with the air of the room.

<sup>1</sup> Obtainable from National Fire Protection Association, 40 Central Street, Boston, Mass.

When extension cord portable lamps are used, drop cord shall be properly inclosed in flexible steel conduit, or armored cord with standard terminal fittings. Lamps shall be inclosed in portable dust-proof fixtures equipped with proper guards.

84. Light for bins, hoppers, and other inclosed spaces shall be provided by fixed ceiling lights, protected by double globes, or preferably by inclosing them behind large heavy glass ceiling domes.

85. 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.

86. 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 Fire Protection Association for the Installation of Blower and Exhaust Systems.<sup>1</sup>)

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

#### 90. 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.

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.

#### 100. Housekeeping.

101. All 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.

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<sup>1</sup> Obtainable from National Fire Protection Association, 40 Central Street, Boston, Mass.

# SAFETY CODE FOR THE PREVENTION OF DUST EXPLOSIONS IN FLOUR AND FEED MILLS

## Introduction.

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.

## 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 entirely to 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 suction 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<sup>1</sup> 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 Fire Protection Association for the Installation of Blower and Exhaust Systems.<sup>1</sup>)

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<sup>1</sup> Obtainable from National Fire Protection Association, 40 Central Street, Boston, Mass.

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 further 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.

## **SAFETY CODE FOR THE PREVENTION OF DUST EXPLOSIONS IN TERMINAL GRAIN ELEVATORS**

### **Introduction.**

This code provides such regulations as are particularly applicable only to elevators erected subsequent to the adoption of this report.

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.

### **Housekeeping.**

Good housekeeping and clean premises are the first essential to the elimination of the explosion hazard. Consequently the adoption of the following regulations is not intended to lessen in any way the responsibility of the owner or operator in this respect.

### **Construction of buildings.**

1. All buildings shall be constructed entirely of fire-resistive materials.

2. Construction shall 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 entirely to eliminate ledges then such ledges shall be finished with smooth surface and shall be made as steep as possible. All pipes, conduits, etc., that of necessity are exposed shall be fastened to walls or ceilings in such a manner as to present a minimum surface for the collection of dust.

3. Roofs and side walls of belt-conveyor galleries, the side walls of all cupolas above bins, and all curtain walls below bins shall be so constructed as to offer minimum resistance to explosive energy.

**NOTE.**—Such construction should preferably be of light material such as galvanized iron, corrugated zinc, or corrugated asbestos, or may be of brick, tile, or gunite of light construction. Concrete may be used if window area is provided in accordance with section 7. For cupola construction this requirement applies only to the curtain or panel walls between columns.

4. (a) The track shed or building in which the operations of loading and unloading cars are carried on may be built immediately adjacent to the working house, but in such case shall be separated from the working house by a solid dust-proof partition of light material. Fixed windows may form a part of the partition. Doors in the partition are not desirable; when necessary, they shall be of the self-closing type.

(b) All other buildings forming a part of, or an adjunct to, the elevator proper shall be separated from each other by as great a distance as is practicable. Connections between buildings shall be

only by belt galleries, tunnels, or spouts. Tunnels between buildings when not wholly underground shall be provided with natural light and in all cases shall have adequate ventilation. At points where galleries or tunnels are connected to main buildings partitions or fire doors shall be provided. These partitions shall be solid except for the entrance doors and apertures for conveyor belts. The entrance doors shall be hinged to swing into the tunnels and shall be so arranged as to be self-closing. Small doors or slides equipped with fusible links, or automatic closing devices, as best adapted to particular conditions, shall be provided to close the apertures for conveyor belts in case of fire or explosion.

5. All working house bins shall be covered, and it is recommended that bins in the storage annex be covered. The side walls of all covered bins shall extend solidly to the roof of the bins, there being no connection between bins. All covered bins shall be vented to the outside atmosphere except that interior working house bins may be vented into the story over bins when on account of mechanical difficulties it is impossible to vent such bins to the outside atmosphere. Vent pipes shall be of sufficient size for the purpose intended.

6. 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.

7. All buildings and operating rooms shall be provided with a large area of windows, or a combination of windows and louvers; minimum allowance to be as follows:

For cupolas and for drier building, 40 per cent of the free-wall area (space between columns).

For track shed and first story of other buildings, 50 per cent of free wall area (space between columns).

All windows shall be glazed with plain glass, and shall be easily operated at all times. Windows shall be arranged to provide the maximum ventilation when open, and shall be preferably of the hinged or tilting type.

8. Ends of working house first story, and the track shed, shall be equipped with rolling steel or incombustible sliding or swinging doors. Exterior side walls of working house and track shed may be equipped with similar doors, if found more practicable than windows, except that when the working house and track shed adjoin the common partition wall shall be permanent, as specified in section 4.

9. Basements of all buildings shall be of such construction as to permit the free circulation of air to all parts. Basements of all storage annexes more than 100 feet in width shall be vented by air shafts exhausting above the roof, or by other approved method. When the natural ventilating capacity is not sufficient to provide one complete change of air per hour, fans or blowers shall be provided. To provide adequate air inlet in basements at all times, permanent openings shall be provided in addition to the doors and windows. Roofs of track sheds, drier buildings, galleries, and all cupolas shall be provided with sufficient monitors or ventilators to insure, in con-

junction with the windows, one complete change of air per hour in the area thus ventilated.

10. All stairways and passenger elevators shall be inclosed in fire-resistive partitions with self-closing doors.

11. Fire escapes shall be provided for all main buildings of the elevator in accordance with State or city regulations.

#### **Equipment.**

12. All elevator leg casings shall be of steel or concrete and all spouts and screw conveyors shall be constructed of steel. Leg casings, spouts, and screw conveyors shall be so designed and so constructed as to be dust proof.

13. Where it is necessary, for convenience of operators, to provide doors or openings in the leg casings, spouts, or screw conveyors, such openings shall be provided with dust-proof covers.

14. In so far as possible all spouts shall be fixed, with the exception that portable spouts may be used in the first story of the working house, and Mayo or telescope spouts may be used on the bin or distributing floor in the cupola. Open ends of all spouts that are liable to emit any volume of dust through back pressure shall be provided with hinged dampers or valves. All spouts passing through building walls shall be equipped with dampers or valves with suitable stops.

15. All conveyor belts delivering grain to an elevator leg shall be equipped with some type of mechanical or electrical governor or control that will automatically stop the conveyor-belt motor when the leg chokes or slows down.

16. All elevator legs should be provided with nonchokable boots.

17. Elevator legs should be provided with automatic back stops.

18. All motors driving elevator legs shall be of such capacity as to enable the leg to elevate the maximum amount of grain that can be delivered by the largest single tributary spout or conveyor. All leg motors shall be equipped with an overload relay attachment which will automatically stop the motor in case of choke at the boot; leg motors shall also be equipped with no-voltage release. When elevator legs are driven by a line shaft they shall be equipped with an automatic signal, either visual or audible, or both, that will register when the leg begins to slow down, thus indicating to the operator the possibility of a choke at the boot.

19. Ball or roller bearings shall be used on all fans and cleaning machines and whenever practicable on belt conveyors, trippers, and elevator boots. On all equipment not readily adaptable to the use of ball or roller bearings the standard type bearing best suited to local climatic conditions may 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.

20. All cleaning machines shall be set a sufficient distance above the floor to permit of easy cleaning around and under them. In no case shall machines be set less than 8 inches above the floor.

21. All belt conveyors shall be raised a sufficient distance from the floor to permit of easy sweeping under them.

22. All machinery shall be constructed of fire-resistive materials.

#### **Driers.**

23. All drier units shall be placed in a separate building.

24. Each drier unit shall be separated from others by means of light dust-proof partitions.

25. Garners over driers shall be constructed of either steel or concrete, preferably closed on top, and when so closed vented to the outside atmosphere.

26. Grain may be transferred to or from the driers by means of spouts or conveyors. Spouts to drier garners shall be carefully connected to prevent dust escape.

27. The coils in driers shall be so constructed or installed as to prevent any accumulation of dust on same.

28. Where air is exhausted from drier or cooler to a containing room, fans and motors shall be segregated from the balance of the equipment by means of partitions. These partitions may be constructed of light material.

29. Motors for fan drives shall preferably be direct connected.

30. Hoppers under cooling section of driers shall be of steel or concrete and dust proof.

31. Where air is exhausted from a drier or cooler, or both, to a containing room, the floor of this room shall be of gratings.

32. Dust hoppers connected to live-dust pipes shall be provided under such gratings.

#### **Removal of suspended dust.**

33. All elevator heads, elevator boots, garners and scale hoppers, scale discharge spouts, fixed belt loaders, and belt discharge spouts shall be provided with adequate positive air aspiration, so arranged as to collect only the floating dust that might otherwise escape into the building. This installation shall conform with the findings of the Underwriters' Laboratories as embodied in their report Miscellaneous Hazards 1148, entitled "An Investigation of the Suction Method of Control of Floating Dust in Terminal Grain Elevators."<sup>2</sup>

34. All drier units shall be provided with an adequate system for the removal of dust created through the operation of driers.

35. All cleaning machines shall be equipped with dust-collecting systems.

36. All dust collectors shall be of cyclone type, at least 90 per cent efficient, and shall be located outside the elevator buildings.

37. All dust collectors shall exhaust 10 feet or more above the roof of the plant, or be so arranged that there will be no opportunity for the dust from the exhaust to get back into the elevator.

#### **Removal of static dust.**

38. All elevators shall be equipped throughout with some type of pneumatic or other effective system for the removal of static dust. The use of a pneumatic system is recommended, except in basements or first floors.

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<sup>2</sup> Obtainable from Underwriters' Laboratories (Inc.), 207 East Ohio Street, Chicago, Ill.; National Fire Protection Association, 40 Central Street, Boston, Mass.; or National Safety Council, 108 East Ohio Street, Chicago, Ill.

39. So far as practicable the use of brooms and brushes for dust removal shall be discontinued and more modern apparatus installed. Proper construction will help minimize the need for the brush.

40. For removal of dust from motors, drier coils, and other inaccessible surfaces, all elevators shall 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 compressor set, 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 elevator.

**Electrical equipment.**

41. All electrical wiring and equipment shall be installed in accordance with the National Electrical Code.

# SAFETY CODE FOR PULVERIZING SYSTEMS FOR SUGAR

## Introduction.

This code eliminates or reduces the hazards inherent in the manufacture of pulverized sugar, particularly the hazard of its 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 and confine the ignition; proper venting of the apparatus and ventilation of the pulverizing department are important.

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 term “pulverizing department” as used in these regulations comprises the portion of the plant in which the pulverizing processes are carried on. The equipment usually consists of the mills or pulverizers, scalpers, bolters or screens, separators or dust collectors, spouts, and conveying apparatus.

## 1. Location.

(a) The processes of pulverizing sugar 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 incombustible 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.

## 2. Construction.

(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-inch reinforced concrete or the equivalent in strength and fire resistance.

(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.

The arrangement shall be such that the maximum distance from any point of the room to the nearest glass or equivalent area is not greater than 1.02 times the least horizontal dimension of the room.

Thin glass skylights may be accepted in part or entirely in lieu of the glass area or its equivalent, provided the relations of areas and distances given in this rule are observed.

When structural conditions prevent the close observance of this rule, a deviation of not over 10 per cent in the dimensions may be permitted by the inspection department having jurisdiction, provided the minimum glass or equivalent area under this rule is observed.

### 3. Communications.

(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 should be protected by standard self-closing, hinged class B fire doors, 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 the openings.

(b) Where power is transmitted to apparatus within the rooms from any driving mechanism or unit outside of same, the transmission medium—belt or chain—shall be encased both inside and outside of the pulverizing department in dust-tight inclosure, constructed of substantial noncombustible material. Where power is transmitted by means of shafts, these shall pass through close-fitting shaft hole in wall or partition.

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

(d) No conveyors, spouts or chutes shall pass through any of the inner or separating walls of the portions of the plant containing the pulverizing department.

In no case shall the materials be conveyed through such walls by means of air currents. If screw conveyors are used for this purpose they shall be fully inclosed in tight, substantial, metal housings, and 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.

(e) Spouts through floors, walls, or partitions of the pulverizing department shall be of substantial metal construction and tight. (See Regulations of the National Fire Protection Association for Blower and Exhaust Systems,<sup>1</sup> sec. 11.)

### 4. Power.

(a) If electric motors are used, these should preferably be located outside of the pulverizing department and the power transmitted as noted under section 3(b). If inside of this department, they shall be in accordance with the standards of the National Electrical Code<sup>1</sup> for dusty locations.

(b) All controlling and circuit-breaking devices, if within the pulverizing department, shall be of the inclosed approved safety type; cabinets or inclosure shall be dust tight and kept fully closed when apparatus is in operation. (See National Electrical Code.<sup>1</sup>)

### 5. Lighting.

(a) Electric incandescent lights only shall be permitted in the pulverizing department. Lamps shall be inclosed in dust-proof

<sup>1</sup> Obtainable from National Fire Protection Association, 40 Central Street, Boston, Mass.

globes provided with approved wire guards, in accordance with the National Electrical Code.<sup>1</sup>

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

#### 6. Wiring.

All wiring shall be in conduit, in accordance with the National Electrical Code.<sup>1</sup>

#### 7. Preventive measures.

(a) All apparatus must 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, one-piece cast-iron driven pulleys shall be used. All apparatus should be equipped with such devices as will prevent ignition, or confine the results of ignition, and 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 where the heating of the bearing 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 sugar delivered to the mills or pulverizers shall be through  $\frac{1}{4}$ -inch wire-mesh screens and over self-cleaning magnetic separators. If sugar is dumped into delivery hoppers from a floor above the mills, these hoppers should have a curbing at least 7 inches above the floors and be provided with screens of  $\frac{1}{4}$ -inch 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 shall 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 sugar shall 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 sugar in such a manner as to keep a small space immediately underneath or near the discharge filled up with pulverized sugar, thus smothering any spark that may originate in the mill. This can be

<sup>1</sup> Obtainable from National Fire Protection Association, 40 Central Street, Boston, Mass.

effected either by means of a revolving choke valve or, if sugar 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 bearing shall not extend into the casings. (See Regulations of the National Fire Protection Association for the Installation of Blower and Exhaust Systems.<sup>1</sup>)

(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 if 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 the Installation of Blower and Exhaust Systems,<sup>1</sup> Class C.)

(j) 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 must be substantially constructed of metal and be carried out of doors as directly as possible, avoiding especially short turns—never through an adjoining building or room—and be properly proportioned.

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.

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

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<sup>1</sup> Obtainable from National Fire Protection Association, 40 Central Street, Boston, Mass.

## **SAFETY CODE FOR PULVERIZING SYSTEMS FOR COCOA**

### **Introduction.**

This code eliminates or reduces the hazards inherent in the manufacture of pulverized cocoa, particularly by avoidance of 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.

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.

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 term “pulverizing department,” as used in these regulations, comprises the portion of the plant in which the pulverizing processes are carried on. The equipment may consist of the mills or pulverizers, scalpers, bolters or screens, dust collectors, and conveying apparatus.

### **1. Location.**

(a) The processes of pulverizing cocoa 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 walls exposing other buildings, to be of light incombustible materials.

(b) If the processes must be carried on in the main plant, the portion of the plant devoted to them shall be segregated and be located, if possible, in the upper stories under the roof.

### **2. Construction.**

(a) When the processes are carried on within the main building or buildings of the plant, 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 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 one-hour fire test.

(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. The arrangement shall be such that the maximum distance from any point of the room

to the nearest glass or equivalent area is not greater than 1.02 times the least horizontal dimension of the room.

Thin glass skylights may be accepted in part or entirely in lieu of the glass area or its equivalent, provided the relations of areas and distances given in this rule are observed.

When structural conditions prevent the close observance of this rule, a deviation of not over 10 per cent in the dimensions may be permitted by the inspection department having jurisdiction, provided the minimum glass or equivalent area under this rule is observed.

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

### 3. Communications.

(a) Access to the pulverizing department should be preferably from the outside; this can be accomplished by means of balconies. When this is not feasible and direct communications are required, these should be protected by standard self-closing hinged class B 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 fire doors may be used to protect the openings.

(b) Where power is transmitted to apparatus within the pulverizing room from any driving mechanism or unit outside, the transmission medium shall pass through a close-fitting passage in wall or partition.

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

(d) Conveyors, spouts, and chutes must be of substantial metal construction and tight; with the exception of conveyors for raw or finished product in bulk, they shall not pass through any of the walls or floors separating the pulverizing department from other portions of the building.

### 4. Power.

(a) If electric motors are used, these should preferably be located outside of the pulverizing department and the power transmitted as noted under communications. If inside of this department, they must be in accordance with the standards of the National Electrical Code<sup>1</sup> for dusty locations.

(b) All controlling and circuit-breaking devices, if within the pulverizing department, must be of the inclosed approved safety type; cabinets or inclosure shall be dust tight and kept fully closed when apparatus is in operation. (See National Electrical Code.<sup>1</sup>)

### 5. Lighting.

(a) Electric incandescent lights only shall be permitted in the pulverizing department. Lamps shall be inclosed in dust-proof globes provided with approved wire guards, in accordance with the National Electrical Code.<sup>1</sup>

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

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<sup>1</sup> Obtainable from National Fire Protection Association, 40 Central Street, Boston, Mass.

## 6. Wiring.

All wiring shall be in conduit, in accordance with the National Electrical Code.<sup>1</sup>

## 7. Preventive measures.

(a) All apparatus must be properly and securely installed to insure constant true alignment and avoid hot bearings or friction, and no moving part 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 shall be used. Bearings shall be self-lubricating, if possible, and all bearings shall be so designed as to be dust tight. The apparatus should be equipped with such devices as will prevent ignition, or confine the results of ignition, and 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.

NOTE.—Attention is directed to the fact that warning of the overheating of bearings, in dusty and inaccessible locations and where the overheating of the bearing 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 systems, together with their pulleys, shafting, and belts shall be electrically grounded in an effective manner.

(c) All cocoa delivered to the mills or pulverizers shall pass over self-cleaning magnetic separators.

(d) Delivery spouts or receiving hoppers immediately above the mills, which require openings for inspection of the cocoa, 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 shall 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 shall 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 the pulverized product in such a manner as to keep a small space immediately underneath or near the discharge filled up with 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 the product 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. The exhaust fan should be located beyond the collector. Ample clearance shall be provided between the blades and

<sup>1</sup> Obtainable from National Fire Protection Association, 40 Central Street, Boston, Mass.

the casing. The fan bearings must not extend into the casings. (See Regulation of the National Fire Protection Association for the Installation of Blower and Exhaust Systems.<sup>1</sup>)

(h) All dust collectors (except those of cloth type) shall be constructed throughout of noncombustible materials; cloth-type collectors shall be provided with tight metal inclosures or their equivalent. The fabric of cloth-type collectors shall 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 the Installation of Blower and Exhaust Systems,<sup>1</sup> Class C.)

(i) Pressure relief vents must be of ample size. 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 as possible, avoiding especially short turns—never through an adjoining building or room—and be properly proportioned.

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.

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

### 8. Housekeeping.

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 cocoa is essential. Accumulations of escaping cocoa dust 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.

### 9. Fire protection.

The building or rooms in which the processes of pulverizing are carried on should be protected by a system of approved automatic sprinklers and approved first-aid fire appliances, together with small hose. (See Regulations of the National Fire Protection Association for First Aid Fire Appliances.<sup>1</sup>)

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<sup>1</sup> Obtainable from National Fire Protection Association, 40 Central Street, Boston, Mass.

## **SAFETY CODE FOR THE INSTALLATION OF PULVERIZED-FUEL SYSTEMS**

### **Introduction.**

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

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 combustion. 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.

### **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.

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

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 such authority.

## **CLASS A AND CLASS B SYSTEMS—GENERAL REGULATIONS**

### **1. Location.**

(a) The process of pulverizing fuel shall preferably be accomplished in a separate detached building used for no other purpose.

(b) Where this is not feasible, this process shall be carried on in a separate room or separate floor used for no other purpose. This sec-

tion shall be separated from the rest of the building by masonry walls and floors.

(*c*) Except for the passage of shafts, pipes, and closed conveyors, these walls and floors 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 a class A automatic sliding fire door and the vestibule opening by a self-closing hinged standard class B fire door at right angles to the sliding door or other suitably protected indirect communication approved by the authority having jurisdiction.

NOTE.—See Regulations of the National Fire Protection Association for the Protection of Openings in Walls and Partitions Against Fire.<sup>1</sup>

## 2. Construction.

(*a*) The building containing pulverizing equipment shall be constructed of incombustible materials 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 for housing pulverizing equipment.

(*c*) A portion of the exterior walls and roofs (considered in lieu of an exterior wall) equal to not less than 10 per cent of the combined area of the inclosing walls shall be of light incombustible material, preferably thin glass. The arrangement shall be such that the maximum distance from any part of the room to the glass is not greater than the least horizontal dimensions of the room.

(*d*) Wired glass, if used, shall be in sash so hung that they will readily swing out in case of an explosion. Such sash shall not be secured; where 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 any explosion in the direction or directions of least exposure.

NOTE.—Wired glass should not be used unless necessary as protection against 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 incombustible 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.

(*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

<sup>1</sup> Obtainable from National Fire Protection Association, 40 Central Street, Boston, Mass.

surface on which dust can lodge. Access must be provided for cleaning all parts of building on which dust may accumulate.

### 3. Ventilation and dust collection.

(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) *Static dust.*—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 sweeping system. The use of compressed air for blowing dust from motors or other equally inaccessible places is recommended, 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 operation of motors and the use of flexible electric cable in coal pulverizing plants, the use of portable vacuum cleaners or air compressors is not recommended. Portable tanks containing compressed air may be used, providing no electrical equipment is operated inside of the pulverizing room in connection therewith.

(e) Pneumatic sweeping 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 separator or separators shall accomplish practically complete separation as there should be no perceptible discharge of dust from the exhauster unless discharge is carried outside of the building. The dust entering the separator shall not directly strike a metallic surface.

(5) The motor and separator should preferably be located outside of the pulverizing room.

### 4. Pulverizer.

All pulverizer mills shall be safeguarded against the hazard of fire or explosion and be operated under competent supervision. Power for operation of pulverizing plant shall be controlled remotely at a readily accessible location and at the mill. Pulverizers, shafting, and

other metal parts of equipment and belts shall be electrically grounded in an effective manner.

#### 5. Magnetic separator.

(a) A magnetic separator shall be provided for each system employing pulverizing mills and shall be installed ahead of the pulverizer. Coal that has passed the magnetic separator shall be protected in such a manner as to prevent the entry of foreign materials.

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

#### 6. Electricity for light and power.

All electrical equipment for light and power in pulverizer house shall conform with the National Electrical Code.<sup>1</sup> 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.

#### 7. Dust collectors.

All dust collectors (except those of cloth type) shall be constructed throughout of noncombustible materials; cloth-type collectors shall be provided with tight metal inclosures or their equivalent. The fabric of cloth-type collectors shall be electrically grounded in an effective manner. All dust collectors used in connection with the pulverizing system, unless located within the pulverizing department, shall be located in separate rooms, properly vented to a safe point outside of the building.

#### 8. Vents.<sup>2</sup>

Safety relief vents shall be liberally provided on all pulverizing equipments, particularly at the mill in the discharge therefrom, 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, and shall not deviate more than  $22\frac{1}{2}^\circ$  from the direction of the pipe or flue from which they lead.

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 to same, provided they are equipped, where practicable, with automatic, balanced, noncorrodible dampers opening in the direction of the normal draft, or with safety relief vents where such dampers cannot be installed.

Such operating vents shall not be taken off safety relief vents nor beyond them (considered in the direction of the normal flow).

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

#### 9. Blowers handling fuel in suspension.

(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.

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<sup>1</sup> Obtainable from National Fire Protection Association, 40 Central Street, Boston, Mass.

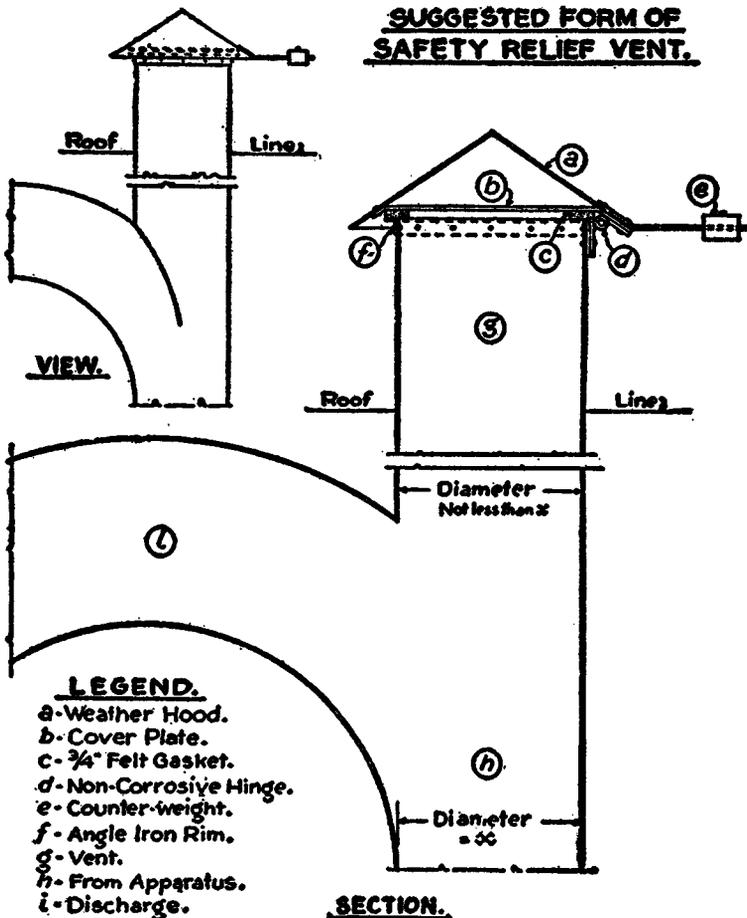
<sup>2</sup> See sketch illustrating suggested form of safety relief vent.

(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 the Installation of Blower and Exhaust Systems.<sup>1</sup>)

#### 10. Driers.

Driers 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.

(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.

<sup>1</sup> Obtainable from National Fire Protection Association, 40 Central Street, Boston, Mass.

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

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

(c) Direct and semi-indirect driers if not located in boiler room as noted in 10 (b) or in a separate building shall be separated from the pulverizing department or any other section of the plant (except as noted under 10 (b) or in similar occupancies) by means of non-combustible 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 one-hour fire test as noted in the foregoing.

(d) *Coals (other than anthracite and coke).*—Drying coals (other than anthracite and coke) increases their tendency 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 shall be so arranged as to leave no dried unground coal in the plant when the mills are shut down for a period of four hours or more. In case all dried coal can not be ground due to the mill being out of service for over four hours, all coal in the dried coal bins and driers shall be drawn out on the floor and, if necessary, cooled before being fed to the mill.

The following table gives the maximum amounts, in hours' supply, of dried coal which may be stored in connection with class A systems in any plant when reaching the mills at various temperatures. This recognizes the fact that the higher the temperature and the longer the time coal is in storage the greater is its tendency to spontaneous ignition.

*Temperatures of coal entering mills and maximum quantity of pulverized coal (other than anthracite and coke) which may be stored*

	Hours' supply
250° F.-----	4
225° F.-----	8
200° F.-----	12
175° F.-----	16
150° F.-----	18

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 prevent excessive rise in temperature of the coal in the driers of the direct or indirect type a temperature-indicating and an 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.

**Norm.**—See also 43 (c).

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

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

**13. Pipe lines.**

(a) All pipes connecting air mills, cyclones, and mill bins should preferably 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 gauge or thicker.

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

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

(d) Where welded sheet-steel fittings are used they shall be provided with removable wearing plates at all points 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 flanges welded to pipes. Such flanges shall be not less than one-fourth inch thick and shall conform as to diameter, bolt circle, and number of bolts with the 125-pound American Standard.

**14. Fire protection.**

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 the Installation, Maintenance, and Use of First Aid Fire Appliances.<sup>1</sup> 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.

Indirect 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.

**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.

**CLASS A SYSTEMS—SPECIFIC REGULATIONS****15. Transportation pipe lines.**

All pipe lines for transporting pulverized coal between mill bins and points of consumption or storage shall be of standard full-weight steel pipe, and fittings equal to the 125-pound American Standard.

**16. Joints and valves.**

All pipe joints shall be securely made so as to insure a dust-tight installation. All control, switching, and shut-off valves shall be of dust-tight construction.

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

**18. Storage and furnace bins.**

(a) Storage and furnace bins for pulverized fuel shall be located as far as consistent with operating requirements from furnaces, and

<sup>1</sup> Obtainable from National Fire Protection Association, 40 Central Street, Boston, Mass.

away from open flames or open lights of any kind. Location shall be such 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 no 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 calked 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. The vent openings shall be equipped with tight-fitting dampers or checks to prevent the entrance of air from the outside.

(d) All bins shall 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.

#### 19. Screw conveyors.

Systems using screw conveyors for handling pulverized fuel shall be 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. Where fuel must be transported 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.

20. (a) 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.

(b) Machinery and all other parts comprising the crushing, drying, pulverizing, and conveying systems shall be electrically grounded in an effective manner.

### CLASS B SYSTEMS—SPECIFIC REGULATIONS

#### 21. Piping.

(a) Distributing piping shall be of suitable metal pipe; flanged joints may be used. Piping and fittings shall be designed to safely withstand the maximum working pressure that may be exerted and

so installed as to be adequately safeguarded against mechanical injury.

(b) In each switch or branch line to burner there shall be installed a suitable check which will be positive in operation.

#### 22. Joints and valves.

All pipe joints, control, switching, and shut-off valves shall be of dust-tight construction.

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

#### 24. Blowers.

(a) Primary blower shall be operated and maintained at a rate producing a primary air pressure higher than that of the secondary or booster.

(b) Motor circuits for primary blower and booster fan shall be protected by the same circuit breaker, switch, or other protective device, so that the stopping of either will cause the simultaneous stopping of the other.

25. All main circulating lines shall be free from baffles, valves, or any obstruction which might cause an accumulation of pulverized fuel in the line.

#### 26. Storage bins.

(a) Storage and furnace bins for pulverized fuel shall be located as far away from furnaces as is consistent with operating requirements and away from open flames or open lights of any kind. Location shall be such that no radiation from furnaces, boiler, 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 no 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 calked 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) Cyclone separators shall not be placed directly over pulverized fuel storage bins, but shall discharge returned coal to the storage bin by means of gravity ducts, screw conveyor, or other equally safe method.

27. (a) In no plant shall coal-storage bins, conveying machinery, or fuel pipe lines be used as a support for electric lighting or power lines other than those installed in conduits.

(b) Machinery and all other parts comprising the crushing, drying, pulverizing, and conveying systems shall be electrically grounded in an effective manner.

### UNIT SYSTEMS—SPECIFIC REGULATIONS

#### 28. Pulverizer.

The pulverizer shall be safeguarded against the hazard of fire or explosion and be operated under competent supervision. Power for

operation of pulverizer shall be controlled remotely at a readily accessible location and at the mill. The pulverizer, blower, and all other metal parts of the equipment, and belts, shall be electrically grounded in an effective manner.

29. If heated air is admitted to the pulverizer, the heating shall be accomplished by an indirect method.

**30. Magnetic separator.**

(a) A magnetic separator shall be provided for each system. In cases where the coal is crushed before being conveyed to the pulverizer the magnetic separator shall be installed between the crusher and the pulverizer.

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

**31. Electricity as power for operating.**

All motors, switches, and other electrical devices in connection with equipment shall conform with the National Electrical Code.<sup>1</sup>

**32. Blower.**

(a) The blower shall be installed on proper foundation and secured in a substantial manner.

(b) Bearings of blower shall not extend inside the blower casing or ducts.

(c) All connections between discharge end of blower and main duct shall be so made as to prevent the leakage of fine dust.

33. All pulverizers shall be constructed as dust tight as practicable and so operated as to avoid emission of dust.

34. No single apparatus shall supply more than two furnaces.

35. The volumetric capacity of the system, including the housing of mill, mixing chamber (if any), fan, and all of the piping, shall not exceed 100 cubic feet unless vented in accordance with the provisions of section 8 of these regulations.

In cases where methods of venting required by this section and sections 40 and 41 are found impracticable, the intent of these requirements will be met if the pipe and fittings connecting the mill and burner or burners is designed for working pressure of 125 pounds.

NOTE.—This construction will require compliance with the Tentative American Standard for Cast-Iron Pipe and Fittings;<sup>2</sup> or, if steel is employed, compliance with the American Society for Testing Materials' Standard Specifications for standard weight welded and seamless steel pipe<sup>3</sup> (serial designation A53-24). Steel pipe larger than 12 inches in diameter shall be of a thickness not less than that required to withstand a test pressure of 450 pounds per square inch as indicated by the formula included in the aforesaid A.S.T.M. standard.

36. All portions of the system shall be confined within the room or section of building where the fuel is prepared or consumed.

37. Piping and fittings shall conform to the requirements of section 13—Pipe lines.

38. Each discharge pipe shall be provided with positive shut-off gate or control.

<sup>1</sup> Obtainable from National Fire Protection Association, 40 Central Street, Boston, Mass.

<sup>2</sup> Obtainable from American Society of Mechanical Engineers, 29 West Thirty-ninth Street, New York, N. Y.

<sup>3</sup> Obtainable from American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa.

39. When two discharge pipes from separate pulverizers deliver to the same furnace through the same nozzle, a valve shall be provided at the junction of the discharge pipes which will automatically shut off the discharging pipe which is not in use.

40. Every vertical or nearly vertical pipe which delivers the fuel to the furnace through a down turn shall be provided with a safety relief vent, as provided for in section 8 of these regulations.

41. No turn at an angle greater than  $45^\circ$  shall be permitted in any pipe unless the pipe is vented as required in these regulations.

42. If a crusher, drier, or other equipment is also used, installation shall be in accordance with the general regulations for class A and class B systems.

#### INSTRUCTION CARDS

43. 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 crushing, drying, and pulverizing plant should be under the supervision of a thoroughly competent and reliable foreman, and only competent and reliable workmen should be employed in connection with those operations.

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

(c) The rotation of the 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 case 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 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.

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

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

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

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

(h) 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 thor-

ough examination shall be made to ensure the removal of smoldering particles of fuel.

(i) All fuel supply lines (of class B and unit systems types) shall be blown clear of fuel when shutting down at close of day.

(j) All conveyors and elevators shall be tightly and securely inclosed and never opened while running. Previous to opening, machinery shall be stopped and dust allowed to settle for a period of 20 minutes.

(k) All stationery lights shall be protected with dust-proof globes and wire guards. 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 drop lights with dust-proof globes utilizing superservice portable cord may be used. Special dust-proof outlets and an adequate number of such cords shall be provided in every pulverizing plant. A conveying and distributing piping shall be inspected daily and any leaks promptly repaired.

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

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## LIST OF BULLETINS OF THE BUREAU OF LABOR STATISTICS

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*A complete list of the reports and bulletins issued prior to July, 1912, as well as the bulletins published since that date, will be furnished on application. Bulletins marked thus (\*) are out of print.*

### **Wholesale Prices.**

No. 284. Index numbers of wholesale prices in the United States and foreign countries. [1921.]

No. 415. Wholesale prices, 1890 to 1925.

### **Retail Prices and Cost of Living.**

\*No. 121. Sugar prices, from refiner to consumer. [1913.]

\*No. 130. Wheat and flour prices, from farmer to consumer. [1913.]

\*No. 164. Butter prices, from producer to consumer. [1914.]

No. 170. Foreign food prices as affected by the war. [1915.]

No. 357. Cost of living in the United States. [1924.]

No. 369. The use of cost-of-living figures in wage adjustments. [1925.]

No. 418. Retail prices, 1890 to 1925.

### **Wages and Hours of Labor.**

\*No. 146. Wages and regularity of employment and standardization of piece rates in the dress and waist industry of New York City. [1914.]

\*No. 147. Wages and regularity of employment in the cloak, suit, and skirt industry. [1914.]

No. 161. Wages and hours of labor in the clothing and cigar industries, 1911 to 1913.

No. 163. Wages and hours of labor in the building and repairing of steam railroad cars, 1907 to 1913.

\*No. 190. Wages and hours of labor in the cotton, woolen, and silk industries, 1907 to 1914.

No. 204. Street railway employment in the United States. [1917.]

No. 225. Wages and hours of labor in the lumber, millwork, and furniture industries, 1915.

No. 265. Industrial survey in selected industries in the United States, 1919.

No. 297. Wages and hours of labor in the petroleum industry, 1920.

No. 348. Wages and hours of labor in the automobile industry, 1922.

No. 356. Productivity costs in the common-brick industry. [1924.]

No. 358. Wages and hours of labor in the automobile-tire industry, 1923.

No. 360. Time and labor costs in manufacturing 100 pairs of shoes. [1924.]

No. 365. Wages and hours of labor in the paper and pulp industry, 1923.

No. 371. Wages and hours of labor in cotton-goods manufacturing, 1924.

No. 374. Wages and hours of labor in the boot and shoe industry, 1907 to 1924.

No. 376. Wages and hours of labor in the hosiery and underwear industry, 1907 to 1924.

No. 377. Wages and hours of labor in woolen and worsted goods manufacturing, 1924.

No. 381. Wages and hours of labor in the iron and steel industry, 1907 to 1924.

No. 387. Wages and hours of labor in the men's clothing industry, 1911 to 1924.

No. 394. Wages and hours of labor in metalliferous mines, 1924.

No. 407. Labor cost of production and wages and hours in the paper box-board industry, 1925.

No. 412. Wages, hours, and productivity in the pottery industry, 1925.

No. 413. Wages and hours of labor in the lumber industry in the United States, 1925.

No. 416. Hours and earnings in anthracite and bituminous coal mining, 1922 and 1924.

No. 421. Wages and hours of labor in the slaughtering and meat-packing industry, 1925.

No. 422. Wages and hours of labor in foundries and machine shops, 1925.

No. 431. Union scale of wages and hours of labor, May 15, 1926. [In press.]

### **Employment and Unemployment.**

- \*No. 109. Statistics of unemployment and the work of employment offices in the United States. [1913.]
- No. 172. Unemployment in New York City, N. Y. [1915.]
- \*No. 183. Regularity of employment in the women's ready-to-wear garment industries. [1915.]
- \*No. 195. Unemployment in the United States. [1916.]
- No. 196. Proceedings of the Employment Managers' Conference held at Minneapolis, Minn., January, 1916.
- \*No. 202. Proceedings of the conference of Employment Managers' Association of Boston, Mass., held May 10, 1916.
- No. 206. The British system of labor exchanges. [1916.]
- \*No. 227. Proceedings of the Employment Managers' Conference, Philadelphia, Pa., April 2 and 3, 1917.
- No. 235. Employment system of the Lake Carriers' Association. [1918.]
- \*No. 241. Public employment offices in the United States. [1918.]
- No. 247. Proceedings of Employment Managers' Conference, Rochester, N. Y., May 9-11, 1918.
- No. 310. Industrial unemployment: A statistical study of its extent and causes. [1922.]
- No. 409. Unemployment in Columbus, Ohio, 1921 to 1925.

### **Proceedings of Annual Meetings of International Association of Public Employment Services.**

- No. 192. First, Chicago, December 19 and 20, 1913; Second, Indianapolis, September 24 and 25, 1914; Third, Detroit, July 1 and 2, 1915.
- No. 220. Fourth, Buffalo, N. Y., July 20 and 21, 1916.
- No. 311. Ninth, Buffalo, N. Y., September 7-9, 1921.
- No. 337. Tenth, Washington, D. C., September 11-13, 1922.
- No. 355. Eleventh, Toronto, Canada, September 4-7, 1923.
- No. 400. Twelfth, Chicago, Ill., May 19-23, 1924.
- No. 414. Thirteenth, Rochester, N. Y., September 15-17, 1925.

### **Women and Children in Industry.**

- No. 116. Hours, earnings, and duration of employment of wage-earning women in selected industries in the District of Columbia. [1913.]
- \*No. 117. Prohibition of night work of young persons. [1913.]
- \*No. 118. Ten-hour maximum working-day for women and young persons. [1913.]
- \*No. 119. Working hours of women in the pea canneries of Wisconsin. [1913.]
- \*No. 122. Employment of women in power laundries in Milwaukee. [1913.]
- No. 160. Hours, earnings, and conditions of labor of women in Indiana mercantile establishments and garment factories. [1914.]
- \*No. 167. Minimum-wage legislation in the United States and foreign countries. [1915.]
- \*No. 175. Summary of the report on conditions of women and child wage earners in the United States. [1915.]
- \*No. 176. Effect of minimum-wage determinations in Oregon. [1915.]
- \*No. 180. The boot and shoe industry in Massachusetts as a vocation for women. [1915.]
- \*No. 182. Unemployment among women in department and other retail stores of Boston, Mass. [1916.]
- No. 193. Dressmaking as a trade for women in Massachusetts. [1916.]
- No. 215. Industrial experience of trade-school girls in Massachusetts. [1917.]
- \*No. 217. Effect of workmen's compensation laws in diminishing the necessity of industrial employment of women and children. [1918.]
- No. 223. Employment of women and juveniles in Great Britain during the war. [1917.]
- No. 253. Women in lead industries. [1919.]

### **Workmen's Insurance and Compensation (including laws relating thereto).**

- \*No. 101. Care of tuberculous wage earners in Germany. [1912.]
- \*No. 102. British national insurance act. 1911.
- \*No. 103. Sickness and accident insurance law of Switzerland. [1912.]
- No. 107. Law relating to insurance of salaried employees in Germany. [1913.]
- \*No. 155. Compensation for accidents to employees of the United States. [1914.]
- No. 212. Proceedings of the conference on social insurance called by the International Association of Industrial Accident Boards and Commissions, Washington, D. C., December 5-9, 1916.

**Workmen's Insurance and Compensation—Continued.**

- No. 248. Workmen's compensation legislation in the United States and foreign countries, 1917 and 1918.
- No. 801. Comparison of workmen's compensation insurance and administration. [1922.]
- No. 812. National health insurance in Great Britain, 1911 to 1920.
- No. 879. Comparison of workmen's compensation laws of the United States as of January 1, 1925.
- No. 423. Workmen's compensation legislation of the United States and Canada, as of July 1, 1926.

**Proceedings of Annual Meetings of the International Association of Industrial Accident Boards and Commissions.**

- \*No. 210. Third, Columbus, Ohio, April 25-28, 1916.
- No. 248. Fourth, Boston, Mass., August 21-25, 1917.
- No. 264. Fifth, Madison, Wis., September 24-27, 1918.
- \*No. 278. Sixth, Toronto, Canada, September 23-26, 1919.
- No. 281. Seventh, San Francisco, Calif., September 20-24, 1920.
- No. 304. Eighth, Chicago, Ill., September 19-23, 1921.
- No. 333. Ninth, Baltimore, Md., October 9-13, 1922.
- No. 359. Tenth, St. Paul, Minn., September, 24-26, 1923.
- No. 385. Eleventh, Halifax, Nova Scotia, August 26-28, 1924.
- No. 395. Index to proceedings, 1914-1924.
- No. 406. Twelfth, Salt Lake City, Utah, August 17-20, 1925.
- No. 432. Thirteenth, Hartford, Conn., September 14-17, 1926.

**Industrial Accidents and Hygiene.**

- \*No. 104. Lead poisoning in potteries, tile works, and porcelain enameled sanitary ware factories. [1912.]
- No. 120. Hygiene in the painters' trade. [1913.]
- \*No. 127. Dangers to workers from dust and fumes, and methods of protection. [1913.]
- \*No. 141. Lead poisoning in the smelting and refining of lead. [1914.]
- \*No. 157. Industrial accident statistics. [1915.]
- \*No. 165. Lead poisoning in the manufacture of storage batteries. [1914.]
- \*No. 179. Industrial poisons used in the rubber industry. [1915.]
- No. 188. Report of British departmental committee on the danger in the use of lead in the painting of buildings. [1916.]
- \*No. 201. Report of committee on statistics and compensation-insurance cost of the International Association of Industrial Accident Boards and Commissions. [1916.]
- \*No. 207. Causes of death by occupation. [1917.]
- \*No. 209. Hygiene of the printing trades. [1917.]
- No. 219. Industrial poisons used or produced in the manufacture of explosives. [1917.]
- No. 221. Hours, fatigue, and health in British munitions factories. [1917.]
- No. 230. Industrial efficiency and fatigue in British munitions factories. [1917.]
- \*No. 231. Mortality from respiratory diseases in dusty trades (inorganic dusts). [1918.]
- No. 234. Safety movement in the iron and steel industry, 1907 to 1917.
- \*No. 236. Effect of the air hammer on the hands of stonecutters. [1918.]
- No. 249. Industrial health and efficiency. Final report of British Health of Munition Workers Committee. [1919.]
- \*No. 251. Preventable death in the cotton-manufacturing industry. [1919.]
- No. 256. Accidents and accident prevention in machine building. [1919.]
- No. 267. Anthrax as an occupational disease. [1920.]
- No. 276. Standardization of industrial accident statistics. [1920.]
- No. 280. Industrial poisoning in making coal-tar dyes and dye intermediates. [1921.]
- No. 291. Carbon monoxide poisoning. [1921.]
- No. 298. The problem of dust phthisis in the granite-stone industry. [1922.]
- No. 298. Causes and prevention of accidents in the iron and steel industry, 1910 to 1919.
- No. 306. Occupational hazards and diagnostic signs: A guide to impairments to be looked for in hazardous occupations. [1922.]
- No. 339. Statistics of industrial accidents in the United States. [1925.]
- No. 392. Survey of hygienic conditions in the printing trades. [1925.]

**Industrial Accidents and Hygiene—Continued.**

- No. 405. Phosphorus necrosis in the manufacture of fireworks and the preparation of phosphorus. [1926.]
- No. 425. Record of industrial accidents in the United States to 1925.
- No. 426. Deaths from lead poisoning. [In press.]
- No. 427. Health survey in the printing trades, 1922 to 1925. [In press.]
- No. 428. Proceedings of the Industrial Accident Prevention Conference, held at Washington, D. C., July 14-16, 1926.

**Conciliation and Arbitration (including strikes and lockouts).**

- \*No. 124. Conciliation and arbitration in the building trades of Greater New York. [1913.]
- \*No. 133. Report of the industrial council of the British Board of Trade in its inquiry into industrial agreements. [1913.]
- \*No. 139. Michigan copper district strike. [1914.]
- No. 144. Industrial court of the cloak, suit, and skirt industry of New York City. [1914.]
- No. 145. Conciliation, arbitration, and sanitation in the dress and waist industry of New York City. [1914.]
- \*No. 191. Collective bargaining in the anthracite coal industry. [1916.]
- \*No. 198. Collective agreements in the men's clothing industry. [1916.]
- No. 233. Operation of the industrial disputes investigation act of Canada. [1918.]
- No. 255. Joint industrial councils of Great Britain. [1917.]
- No. 258. History of the Shipbuilding Labor Adjustment Board, 1917 to 1919.
- No. 287. National War Labor Board: History of its formation, activities, etc. [1921.]
- No. 303. Use of Federal power in settlement of railway labor disputes. [1922.]
- No. 341. Trade agreement in the silk-ribbon industry of New York City. [1923.]
- No. 402. Collective bargaining by actors. [1926.]
- No. 419. Trade agreements, 1925.

**Labor Laws of the United States (including decisions of courts relating to labor).**

- No. 211. Labor laws and their administration in the Pacific States. [1917.]
- No. 229. Wage-payment legislation in the United States. [1917.]
- No. 235. Minimum-wage legislation in the United States. [1921.]
- No. 321. Labor laws that have been declared unconstitutional. [1922.]
- No. 322. Kansas Court of Industrial Relations. [1923.]
- No. 343. Laws providing for bureaus of labor statistics, etc. [1923.]
- No. 370. Labor laws of the United States, with decisions of courts relating thereto. [1925.]
- No. 403. Labor legislation of 1925.
- No. 408. Labor laws relating to payment of wages. [1926.]
- No. 417. Decisions of courts and opinions affecting labor, 1925.

**Foreign Labor Laws.**

- \*No. 142. Administration of labor laws and factory inspection in certain European countries. [1914.]

**Vocational and Workers' Education.**

- \*No. 159. Short-unit courses for wage earners, and a factory school experiment.
- \*No. 192. Vocational education survey of Richmond, Va. [1915.]
- No. 199. Vocational education survey of Minneapolis, Minn. [1916.]
- No. 271. Adult working-class education in Great Britain and the United States. [1920.]

**Safety Codes.**

- No. 331. Code of lighting factories, mills, and other work places.
- No. 336. Safety code for the protection of industrial workers in foundries.
- No. 338. Safety code for the use, care, and protection of abrasive wheels.
- No. 350. Specifications of laboratory tests for approval of electric headlighting devices for motor vehicles.
- No. 351. Safety code for the construction, care, and use of ladders.
- No. 364. Safety code for mechanical power-transmission apparatus.
- No. 375. Safety code for laundry machinery and operation.
- No. 378. Safety code for woodworking plants.
- No. 382. Code of lighting school buildings.
- No. 410. Safety code for paper and pulp mills.
- No. 430. Safety code for power presses and foot and hand presses.

**Industrial Relations and Labor Conditions.**

- No. 237. Industrial unrest in Great Britain. [1917.]
- No. 340. Chinese migrations, with special reference to labor conditions. [1923.]
- No. 349. Industrial relations in the West Coast lumber industry. [1923.]
- No. 361. Labor relations in the Fairmont (W. Va.) bituminous coal field. [1924.]
- No. 380. Postwar labor conditions in Germany. [1925.]
- No. 383. Works council movement in Germany. [1925.]
- No. 384. Labor conditions in the shoe industry in Massachusetts, 1920 to 1924.
- No. 399. Labor relations in the lace and lace-curtain industries in the United States. [1925.]

**Welfare Work.**

- \*No. 123. Employers' welfare work. [1913.]
- No. 222. Welfare work in British munitions factories. [1917.]
- \*No. 250. Welfare work for employees in industrial establishments in the United States. [1919.]

**Cooperation.**

- No. 313. Consumers' cooperative societies in the United States in 1920.
- No. 314. Cooperative credit societies in America and in foreign countries. [1922.]

**Housing.**

- \*No. 158. Government aid to home owning and housing of working people in foreign countries. [1914.]
- No. 268. Housing by employers in the United States. [1920.]
- No. 295. Building operations in representative cities in 1920.
- No. 424. Building permits in the principal cities of the United States, 1925.

**Proceedings of Annual Conventions of the Association of Governmental Labor Officials of the United States and Canada.**

- No. 266. Seventh, Seattle, Wash., July 12-15, 1920.
- No. 307. Eighth, New Orleans, La., May 2-8, 1921.
- \*No. 323. Ninth, Harrisburg, Pa., May 22-26, 1922.
- No. 352. Tenth, Richmond, Va., May 1-4, 1923.
- No. 389. Eleventh, Chicago, Ill., May 19-23, 1924.
- No. 411. Twelfth, Salt Lake City, Utah, August 13-15, 1925.
- No. 429. Thirteenth, Columbus, Ohio, June 7-10, 1926.

**Miscellaneous Series.**

- \*No. 174. Subject index of the publications of the United States Bureau of Labor Statistics up to May 1, 1915.
- No. 208. Profit sharing in the United States. [1916.]
- No. 242. Food situation in central Europe, 1917.
- No. 254. International labor legislation and the society of nations. [1919.]
- No. 268. Historical survey of international action affecting labor. [1920.]
- No. 282. Mutual relief associations among Government employees in Washington, D. C. [1921.]
- No. 299. Personnel research agencies. A guide to organized research in employment, management, industrial relations, training, and working conditions. [1921.]
- No. 319. The Bureau of Labor Statistics: Its history, activities, and organization. [1922.]
- No. 326. Methods of procuring and computing statistical information of the Bureau of Labor Statistics. [1923.]
- No. 342. International Seamen's Union of America: A study of its history and problems. [1923.]
- No. 346. Humanity in government. [1923.]
- No. 372. Convict labor in 1923.
- No. 386. The cost of American almshouses. [1925.]
- No. 398. Growth of legal-aid work in the United States. [1926.]
- No. 401. Family allowances in foreign countries. [1926.]
- No. 420. Handbook of American trade-unions. [1926.]