NFPA No.

655

PREVENTION OF SULFUR FIRES AND EXPLOSIONS 1971

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Official NFPA Definitions

Adopted Jan. 23, 1964: Revised Dec. 9, 1969. Where variances to these definitions are found, efforts to eliminate such conflicts are in process.

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This material has been developed in the interest of safety to life and property under the published procedures of the National Fire Protection Association. These procedures are designed to assure the appointment of technically competent Committees having balanced representation from those vitally interested and active in the areas with which the Committees are concerned. These procedures provide that all Committee recommendations shall be published prior to action on them by the Association itself and that following this publication these recommendations shall be presented for adoption to the Annual Meeting of the Association where anyone in attendance, member or not, may present his views. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accepts any liability resulting from compliance or noncompliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

Standard for

PREVENTION OF SULFUR FIRES AND EXPLOSIONS

NFPA No. 655 — 1971

1971 Edition of No. 655

This edition of NFPA No. 655 was prepared by the Sectional Committee on Miscellaneous Dusts and approved by the Correlating Committee. It was adopted at the 1971 NFPA Annual Meeting and supersedes the 1968 edition. Principal changes were directed toward strengthening the standard by making a number of previous recommendations mandatory requirements.

Origin and Development of No. 655

This standard was first presented by the Committee on Dust Explosion Hazards as a progress report in 1938 and was tentatively adopted in 1939. After revision it was officially adopted in 1940. Amendments recommended by the Committee were adopted in 1946, 1947, 1959, and 1968.

The 1968 edition of NFPA No. 655 was approved by the American National Standards Institute as ANSI Standard Z12.12 on October 18, 1968. The 1971 edition has been submitted to ANSI.

Committee on Dust Explosion Hazards

Correlating Committee

T. T. Singer, *Chairman*,
Western Actuarial Bureau, 222 W. Adams St., Chicago, Ill. 60606

W. L. Sands†, *Secretary*,
Western Actuarial Bureau, 222 W. Adams St., Chicago, Ill. 60606

R. W. Andrews, Jr., American Society of Mechanical Engineers.

John Nagy, U. S. Bureau of Mines and NFPA Committee on Explosion Protection Systems.

G. D. Perkins, Mill Mutual Fire Prevention Bureau.

J. K. Sundermeyer, Society of the Plastics Industry, Inc.

James B. Walker, Jr., American Boiler Mfrs. Assn.

SCOPE: To review and correlate the activities of the Sectional Committees reporting through it. This Correlating Committee shall act in an administrative capacity to determine that no conflicts exist and that satisfactory correlation is achieved among the recommendations of the Sectional Committees. Each report of a Sectional Committee shall be reviewed and approved by a two-thirds affirmative vote of the Correlating Committee before being submitted to an NFPA Annual Meeting. Where the Correlating Committee finds a conflict or lack of correlation, it shall refer the report back to the appropriate Sectional Committee with an explanation of the reason for so doing.

Sectional Committee on Miscellaneous Dusts

J. K. Sundermeyer, *Chairman*,
American Cyanamid Company, Berdan Avenue, Wayne, N. J. 07470
(rep. Society of the Plastics Industry, Inc.)

David W. Bixby, The Sulphur Institute.

A. Bogot, Combustion Engineering, Inc.

J. J. Burke, American Society of Heating, Refrigerating & Air Conditioning Engineers, Inc.

Dean M. Clark, Grain Elevator and Processing Superintendents.

D. P. Congdon, Factory Insurance Assn.

Harry G. Ford, Jr., International Assn. of Governmental Labor Officials.

Guy Isenberg, Manufacturing Chemists' Assn.

Murray Jacobson, American Industrial Hygiene Assn.

Frank Jun, Quaker Oats Co.

John Nagy, U. S. Bureau of Mines and NFPA Committee on Explosion Protection Systems.

John P. O'Neill, Office of Occupational Safety, Bureau of Labor Standards.

R. H. Pechstein, American Electric Power Corp.

G. D. Perkins, Mill Mutual Fire Prevention Bureau.

J. W. Purman, National Electrical Manufacturers Assn.

J. M. Robinson, American Insurance Assn.

R. F. Schwab, Allied Chemical Corp.

T. T. Singer, Western Actuarial Bureau.

Max Spencer, Grain Elevator & Processing Superintendents.

Paul J. Turner, Great Northern Railway.

George E. Weldon, Factory Mutual Research Corp.

Alternates.

G. Walker Daubenspeck, Office of Occupational Safety, Bureau of Labor Standards. (Alternate to J. P. O'Neill)

Robert W. Nelson, Factory Insurance Assn. (Alternate to D. P. Congdon)

W. L. Sands, Western Actuarial Bureau. (Alternate to T. T. Singer)

SCOPE: The prevention and extinguishment of fires and explosions in processes and industries handling all dusts not specifically included within the scope of other sectional committees of the Dust Explosion Hazards Committee.

STANDARD FOR PREVENTION OF SULFUR FIRES AND EXPLOSIONS

NFPA No. 655—1971

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CHAPTER 1. INTRODUCTION

11. Scope and Application.

1101. The standard applies only to buildings erected and equipment installed subsequent to the adoption of this Standard.

1102. This standard is designed for application to new installations and when making alterations or extensions to existing equipment. Although it is not retroactive, it is recommended as an advisory guide for operators who may wish to avail themselves of the information herein, to improve existing plants.

1103. For the purpose of this standard sulfur is considered to be a combustible solid at temperatures below the melting point and a combustible liquid at higher temperatures. This standard is issued as a guide to eliminate or reduce the hazard of explosion and fire inherent in the processing and handling of sulfur in industry. It applies to the crushing, grinding or pulverizing of sulfur, and to certain specific operations in handling of sulfur; it does not apply to the mining or transportation of sulfur.

1104. The finely divided sulfur produced during crushing and pulverizing is the most hazardous from an explosion standpoint. Chapter 2 of this standard gives safety precautions for the production, handling, and processing of this fine material. The requirements of Chapter 2 apply also to the preparation and handling of mixtures containing finely divided elemental sulfur in sufficient quantity to render the dust of the mixture combustible as determined by industrial experience or approved laboratory test.

1105. Some explosion and fire hazards accompany the handling and processing of sulfur in bulk in coarse sizes because of the fine dust present with the coarser material. Chapter 3 gives recommended safety practices for handling such bulk material.

1106. Sulfur is handled and processed in liquid and vapor forms in some cases. The liquid is highly combustible and the vapor is explosive when mixed with air in the proper proportions. Recommended safety precautions in handling sulfur in the liquid and vapor phases are given in Chapters 4 and 5.

12. Properties of Sulfur.

1201. Sulfur differs from most other combustible dusts found in industry by having relatively low melting and ignition points. Depending on the purity, sulfur melts at or slightly below 119° C. (246° F.), and the ignition temperature of dust clouds varies upward from approximately 190° C. (374° F.). Dilution of sulfur with inert solids is not effective in raising the ignition temperature.

NOTE: Sulfur should not be handled or stored in the presence of chlorates, nitrates and other oxidizing materials. (See NFPA No. 49, Hazardous Chemicals Data.)

13. Qualifications of Personnel.

1301. The installation, operation, and maintenance of machinery for handling sulfur and particularly for crushing or pulverizing it, should be under the supervision of persons qualified by experience in the design, construction, and operation of such equipment, with particular reference to the material that will be handled.

14. Definitions.

In this Standard 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 means acceptable to the authority having jurisdiction.

CHAPTER 2. CRUSHING AND PULVERIZING

21. General.

2101. Chapter 2 of this standard applies to the production, handling and processing of finely divided sulfur.

2102. Machinery for crushing and pulverizing sulfur is grouped in this standard into the following four types:

Type 1. Slow-speed primary crushers, such as jaw and roll crushers.

Type 2. High-speed primary crushers (such as disk and hammer crushers), pulverizers, and fine grinding equipment of all kinds, except Type 4, having a free internal volume of not more than 500 cubic inches.

Type 3. Crushers and pulverizers similar to Type 2 but having an internal volume greater than 500 cubic inches. This does not include pulverizers described as Type 4.

Type 4. Pulverizers that do not depend upon moving parts for their disintegrating action. The grinding in this type pulverizer is largely accomplished by the attrition of the particles on themselves. Power for moving the particles is furnished by compressed air or other fluid suitable to the material being pulverized.

2103. Operation and maintenance of all crushing and pulverizing machinery shall be under competent supervision.

22. Location, Construction and Explosion Venting of Buildings and Equipment.

2201. The provisions of Article 22 of this standard apply to the production of finely divided sulfur in enclosures or in semienclosed spaces. Sections dealing with venting of buildings apply to enclosures only.

2202. The enclosure or semienclosed space in which any of the four types of machinery described in Section 2102 is used for preparation or air classification of finely divided sulfur shall be used for no other purpose during the period when grinding is in progress, except that containers may be filled with the ground product. Such filled containers shall not be kept in the space with the grinding machinery, but shall be removed as soon as practicable after being filled and no accumulation of filled containers shall be allowed in the space used for grinding. The grinding space should

preferably be detached. Where this is not practicable it shall be separated from other enclosed or semienclosed spaces by a masonry or concrete wall or an equivalent strong steel frame carrying metal lath and cement plaster on both sides. No openings should be permitted other than those necessary for the passage of pipes, shafting, and conveyors. (See Section 2501 for limitation on conveyors). Care shall be taken to vent other walls of the enclosure so that the separating wall shall not be destroyed by the force of an explosion.

2203. Where feasible, all communications between the space used for grinding and the rest of the building shall be from the outside. In cases where this method of access is not feasible in enclosed spaces, indirect communications through separating walls by means of vestibules or stairways may be permitted, provided the wall opening is protected by an automatic sliding fire door approved for Class A situations and the vestibule or stairway opening by a heavy closed hinged fire door approved for Class B situations and at right angles to the sliding door, or there is provided other suitable protected indirect communication approved by the authority having jurisdiction. It is recommended that an emergency escapeway for personnel be provided independently. (See NFPA No. 80, Standard for Fire Doors and Windows.)

2204. All enclosures in which fine grinding is done shall be constructed of noncombustible materials. Steel frame construction, with light nonbearing exterior walls and light roof, is preferable.

2205. Buildings housing operations where dust hazards exist shall have explosion venting through one or more of the following methods: (a) lightweight walls and roof; (b) lightweight wall panels and roof hatches; (c) windows of explosion venting type.

NOTE: Guide for Explosion Venting, NFPA No. 68, provides information on this subject.

2206. Interior and overhead ledges on which dust may accumulate shall be avoided in construction throughout. Where unavoidably present they shall be filled in or roofed with noncomcombustible material at an angle not less than 45 degrees from the horizontal.

2207. Pressure relief vents shall be used liberally on all pulverizing equipment, blower and exhaust systems, elevator heads, and bins into which they discharge. All vent pipes shall lead to outside air by the most direct route. Construction shall be such as to prevent sparks from other operations entering open vent pipes.

Such vents, on systems protected by inert gas, may be closed at the normal exit point by suitable covers which will retain the inertness of the system, but which will open freely to vent explosion pressures.

2208. Where an explosive concentration of dust or vapor may be present within equipment or at equipment charging and discharge openings, the probability of explosion damage can be limited by explosion suppression devices or systems.

23. Electrical Wiring and Equipment.

2301. All electrical wiring and equipment shall conform to the National Electrical Code NFPA No. 70. In spaces containing grinding equipment all electrical wiring and equipment shall be of a Class approved for use in atmospheres containing sulfur dust.

NOTE: Although sulfur is not now included in atmospheres classified as Class II, Group G, it has been the experience of the Sulfur Industry that electrical wiring and equipment meeting the requirements of Articles 500 and 502 of NFPA No. 70 for Class II, Group G, Division 1 is satisfactory.

2302. Provision shall be made for remote control of electric current for both light and power serving spaces in which there is production, handling and processing of finely divided sulfur.

24. Inert Gas.

2401. Use of inert gas is not required with Type 1 machinery.

2402. Type 2 machinery may be operated without inert gas provided that:

(a) The feed and discharge are provided with positive chokes (such as star feeder revolving damper, or screw conveyor with end flights removed from conveyor) where directly connected to the machine.

(b) The chokes and all machinery between are capable of withstanding a bursting pressure of 100 pounds per square inch.

(c) There is frequent inspection of the machinery during operation to detect abnormalities in operating conditions.

2403. When grinding or other processing equipment must be opened for cleaning following an ignition in it, the feed, discharge and other openings shall first be closed by suitable metal

valves or gates. A period of at least 15 minutes should elapse between closure and opening to smother any residual fire in the machine. As an added precaution the equipment should be flooded with inert gas, if available, or with steam, prior to its being opened for inspection and cleaning.

2404. Type 3 pulverizing equipment shall not be operated without use of inert gas as defined and recommended by NFPA No. 69, Standard on Explosion Prevention Systems. Where the pulverized sulfur is removed from this machinery by blower or exhaust systems, inert gas shall be used in all piping and collectors, as in the grinding equipment itself. A reduction in oxygen by carbon dioxide diluent to 11 percent, or by nitrogen diluent to 8 percent, is recommended to prevent ignition of dusts by sparks; where stronger sources of ignition may be present, reduction to 4 percent by carbon dioxide, or 3 percent by nitrogen diluent, is recommended.

NOTE: Inerting by reduction in oxygen content is usually accomplished by introducing flue gas made by burning a suitable fuel. The composition of the resulting "inert" mixture varies with the kind of fuel used. Control, by analysis for carbon dioxide (CO_2), is common practice. Therefore, it is recommended that, to hold the oxygen content of the circulating atmosphere under 11 percent, the CO_2 content therein must be over 9 percent, if from coal; over 7.5 percent, if from fuel oil; or over 6 percent, if from natural gas.

2405. The inert gas system shall be equipped with suitable sampling and recording instruments to obtain a reliable and continuous analysis of the inert gas in that part, or parts, of the equipment where because of pressure conditions, the inertness is normally weakest. Auxiliary instruments should be provided for sampling and recording the quality of the inertness in other parts of the system.

2406. Provision shall be made for the automatic stopping of the machinery when the oxygen content of the gas rises above 11 percent.

2407. Type 4 machinery (air mills), may be operated without the use of inert gas. The large volume of air, high velocities of air, and compact mill units, combine to make inerting with inert gas usually impractical. When inert gas is not used the following requirements shall apply:

(a) Manually operated valves shall be installed at each machine for control of the feed and air lines.

(b) The equipment shall be under competent observation during operation, and shall be shut down for detailed inspection (and for cleaning if necessary) when abnormalities in operation indicate the possibility of fire within the machine. All valves shall be closed before opening the machine. Flooding with inert gas or with steam, combined with delayed opening to permit smothering of any residual fire, is recommended.

(c) Auxiliary dust collectors shall be installed according to the requirements of Section 2504.

25. Conveyors and Collectors.

2501. Only conveyors or spouts with positive seals or chokes such as star feeder, revolving damper, or screw conveyor with end flights removed, shall be permitted to pass through a fire wall separating crushing or pulverizing rooms from adjoining enclosed spaces. The chokes or seals shall be located in a position to prevent the propagation of flame through the fire wall.

2502. During normal operation of the plant, conveyors used to feed or discharge sulfur to or from grinding machinery shall be in dust-tight housings.

2503. Nonferrous buckets or bucket conveyors should be used where they are housed in ferrous casings. In cases where this is impracticable steam should be blown into the elevator boot while the elevator is in operation, or the system should be operated with inert gas as required in Sections 2404–2406.

2504. When pneumatic conveying systems are used, each pulverizer shall have a separate and self-contained system. Collectors shall be in a separate enclosure or entirely outside the building. Cloth-type collectors shall be protected from mechanical damage by tight metal housings which shall be liberally vented directly to the atmosphere.

26. Prevention of Ignition.

2601. Approved magnetic separators of the permanent magnet or self-cleaning electro-magnetic types or approved pneumatic separators shall be installed ahead of all crushers and pulverizers of Types 2, 3, and 4. The installation shall be of sufficient size and proper design to insure the removal of all ferrous material from the sulfur to be ground.

NOTE: It must be recognized that magnetic separators will not remove nonferrous tramp material, including stones, brick and concrete. Every care, with other means, should be taken to ensure exclusion of these materials from the grinding system.

2602. Sulfur dust clouds are readily ignited by weak frictional sparks. All machinery shall be installed and maintained in such condition that the possibility of frictional sparks or heat is reduced to a minimum.

2603. Interlocking controls shall be installed to stop the dust feed if the pulverizer stops, and to stop the dust feed if fans in the system stop for any reason.

2604. All machinery, conveyors, housings, and collectors shall be thoroughly bonded and grounded in accordance with the recommendations of NFPA No. 77, Static Electricity, to prevent the accumulation of static electricity.

2605. All open flames, smoking, and matches shall be prohibited in enclosures containing crushers and pulverizers, except as noted in Section 2606. Uncovered hot surfaces, such as steam lines, etc., which may attain temperatures high enough to melt and ignite sulfur dust shall not be exposed in enclosures housing sulfur processing equipment.

2606. Repairs involving flame, heat or use of hand or power tools shall be made only after all operations have ceased and all sulfur has been removed from the vicinity, or protected in tight noncombustible containers.

2607. Gun-type tools using powder or cartridges for driving pegs or pins into concrete, brick, steel, etc., shall not be used where combustible dust or dust clouds are present. When the use of this type of equipment becomes necessary all dust producing machinery in the area shall be shut down, all equipment, floors and walls shall be carefully cleaned, and all dust accumulations removed. A careful check shall be made to be sure that no cartridges or charges are left on the premises where they could enter equipment or be accidentally discharged after operation of the dust producing or handling machinery is resumed.

27. Housekeeping.

2701. Good housekeeping is of utmost importance. Equipment shall be designed, maintained, and operated in a manner

which will minimize the escape of dust. Accumulations of escaped dust shall not be tolerated in the buildings. It is recommended that the interior of crushing, pulverizing and packaging departments be painted a color which is in contrast with that of the dust.

2702. Bulk accumulations of fine sulfur shall be removed by soft push brooms, and nonsparking scoops or shovels, before vacuum sweeping equipment is used.

2703. The cleaning of surfaces may be by vacuum sweeping devices. If vacuum apparatus is used, either stationary or portable type shall be properly grounded and regularly checked for electrical continuity from pickup nozzle to piping system. Such equipment, if electrical, shall be of a class approved for use in atmospheres containing sulfur dust.

NOTE: Although sulfur is not now included in atmospheres classified as Class II Group G, it has been the experience of the sulfur industry that electrical equipment meeting the requirements for installation in Class II Group G locations is satisfactory. (See NFPA No. 70, the National Electrical Code.)

2704. Blowing down of any surfaces by compressed air is prohibited.

28. Fire Fighting.

2801. The use of pressure liquid streams from hoses or extinguishers should be avoided when fighting fire in finely divided sulfur, as a cloud of dust may be raised which will explode in contact with the fire. Fog nozzles may be used. Finely divided water sprays or mists that settle on the sulfur without disturbing it are suitable. Steam and inert gases are excellent extinguishers for use in containers that can be closed tightly, provided that they are introduced in such manner that the sulfur dust is not disturbed. If a container is closed tightly and the volume of oxygen enclosed is not too large, a fire will be smothered by the sulfur dioxide formed. In all cases it should be certain that the fire is fully extinguished before disturbing the dust, and that the sulfur has cooled sufficiently so that it will not reignite.

2802. It is recommended that at least 2 air supplied masks or self-contained breathing apparatus be available for use in case of sulfur fires. Gas masks approved for acid gases would not provide adequate protection in a serious fire. All respiratory equipment should be inspected at regular intervals and kept in working order at all times.

CHAPTER 3. HANDLING COARSE SIZES OF SULFUR IN BULK

31. In the Open or in Semienclosed Spaces.

3101. Clouds of fine dust arising during the handling of bulk sulfur in the open or in semienclosed spaces are potentially dangerous and arrangements should be such that they will not come in contact with sources of ignition. Industrial experience indicates that conveying machinery should be bonded and grounded in accordance with the recommendations of NFPA No. 77, Static Electricity, to prevent the accumulation of static electricity. Flames, smoking and matches should be prohibited in such areas. Cutting and welding equipment may be permitted for repair work when used with due precaution against ignition of dust. (See NFPA No. 51, Standard for the Installation and Operation of Oxygen-Fuel Gas Systems for Welding and Cutting.) Sulfur ignites easily so that any ignition sources such as spark-producing equipment or exposed hot surfaces over 300°F. should be eliminated.

32. In Enclosed Spaces.

3201. Handling bulk sulfur in enclosures shall be conducted in such manner as to minimize the formation of clouds of sulfur dust in air.

3202. All enclosures should be of noncombustible construction and so designed as to present a minimum of ledges on which dust may lodge. Where such surfaces are unavoidable, they should be roofed at a steep angle to reduce deposition of dust. Direct ventilation to outdoors is recommended.

3203. It is recommended that nonsparking tools be used wherever sulfur is shoveled or otherwise moved by hand, particularly where the tools may come in contact with concrete, stone, or steel.

3204. Dust may arise at points where sulfur is dumped from one container or carrier to another. Care should be taken to prevent scattering such dust. Provide dust-tight housings with sufficient inward air-movement to prevent escape of dust into the surrounding enclosure, or provide an exhaust system for the safe removal of dust from the point of liberation. Where mechanical exhaust systems are used to provide this air movement, they shall conform to NFPA No. 91, Standard for the Installation of Blower

or Exhaust Systems for Dust, Stock and Vapor Removal or Conveying. The provisions of this Section apply to dumping into or drawing from bins.

3205. All elevators and conveyors which agitate the sulfur being transported (such as bucket elevators and screw conveyors) shall be enclosed in dust-tight casings, and shall be equipped with explosion relief vents. All vent pipes shall lead to outside air by the most direct route with provision against entrance of sparks at the end of the vent. Nonferrous buckets or bucket conveyors should be used where these are in ferrous casings. In cases where this is impracticable steam should be blown into the elevator boot while the elevator is in operation, or the system should be operated with inert gas.

3206. All metal parts of machinery and casings thereof, together with metal parts of bins and spouts, shall be adequately bonded and grounded to prevent the accumulation of static electricity in accordance with the recommendations of NFPA No. 77, Static Electricity.

3207. All electrical wiring and equipment installed at points where clouds of dust may be formed, shall be of a class approved for use in atmospheres containing sulfur dust.

NOTE: Although sulfur is not now included in atmospheres classified as Class II Group G, it has been the experience of the sulfur industry that electrical equipment meeting the requirements for installation in Class II Group G locations is satisfactory.

3208. All open flames, smoking, and matches shall be prohibited within enclosures. Heating shall be by indirect means, as by steam or preheated air. Exposed hot elements, such as steam lines should be avoided within the enclosure.

3209. Care shall be taken to minimize the presence of static or settled dust within enclosures and semienclosures and to remove dust accumulations when formed, irrespective of their location. The means of removing dust shall be such as to prevent scattering of the dust deposit.

3210. Repairs involving flame, heat or use of hand or power tools shall be made only after all operations have ceased. Where practical all sulfur shall be removed from the vicinity or protected in tight containers. Where impractical to remove, protection

against sulfur fires can be had by wetting down the sulfur, and keeping a water hose with spray nozzle ready.

3211. Gun-type tools using powder or cartridges for driving pegs or pins into concrete, brick, steel, etc., shall not be used where combustible dust or dust clouds are present. When the use of this type of equipment becomes necessary all dust-producing machinery in the area shall be shut down, all equipment, floors and walls shall be carefully cleaned. All bulk sulfur piles or dust accumulations shall be removed or thoroughly wet down. A careful check shall be made to be sure that no cartridges or charges are left on the premises where they could enter equipment or be accidentally discharged after operation of the dust producing or handling machinery is resumed.

33. Fire Fighting.

3301. In enclosures the statements of Article 28 are applicable with modifications to meet the particular conditions encountered. As bulk sulfur contains only a small proportion of extreme fines, coarser sprays are permissible. Incipient fires in storage piles can frequently be smothered by gently shoveling more sulfur on them to exclude air. It is recommended that automatic sprinkler systems be installed in all enclosures in which sulfur is stored or handled.

CHAPTER 4. LIQUID SULFUR AT NORMAL HANDLING TEMPERATURES

41. General.

4101. This section of the code applies to liquid sulfur in the temperature range of 121°–154°C. (250°–310°F.), which is the normal handling temperature range for the transportation and storage of liquid sulfur. See Chapter 5 for higher temperatures.

4102. The melting point of sulfur is 118.9°C. (246.1°F.).

4103. The vapor concentration above pure sulfur, free of hydrocarbons or hydrogen sulfide in the normal temperature range is too low to form an explosive mixture in an air atmosphere.

4104. The flash point of liquid sulfur varies with purity and with the test method but is always higher than the normal handling temperature. For pure sulfur the flash point will be approximately 188°C. (370°F.). Relatively impure (dark) crude sulfur may have a flash point as low as 168°C. (335°F.)*

42. Fire and Explosion Hazards.

4201. The relatively low ignition temperature of sulfur and the possible presence of hydrogen sulfide are the primary fire and explosion hazards associated with the handling of liquid sulfur. Dark sulfur contains hydrocarbons which react slowly with liquid sulfur to form hydrogen sulfide. Recovered sulfurs, such as those produced from hydrogen sulfide, often contain dissolved hydrogen sulfide. Hydrogen sulfide is quite soluble in liquid sulfur and will be liberated very slowly from a quiescent body of liquid sulfur. Agitation of liquid sulfur can cause a rapid liberation of hydrogen sulfide which may create an explosive mixture in the void space of a storage tank.

4202. In the temperature range at which liquid sulfur is normally transported and stored, the lower explosive limit for hydrogen sulfide in air is about 3.4 percent by volume. This compares with a lower explosive limit of 4.3 percent by volume of hydrogen sulfide in air, measured at room temperature.

4203. Pure sulfur, free of hydrocarbon or hydrogen sulfide will not generate an explosive atmosphere in the temperature range at which liquid sulfur is normally transported and stored.

*Flash point determined by modified open cup method.

43. Detection of Unsafe Conditions.

4301. Devices for measuring the concentration or the explosiveness of gases in the atmosphere over liquid sulfur may be as elaborate as a gas chromatograph, or as simple as the portable type explosimeters. However, the instruments should be constructed for operation in atmospheres containing hydrogen sulfide; sensing elements of some explosimeters are not designed for and are poisoned when used in a hydrogen-sulfide atmosphere.

4302. There are several types of instruments on the market for measuring the lower explosive limit of combustible gases in air. Any such instrument used for detecting explosive atmospheres over liquid sulfur should be capable of measuring the lower explosive limit of hydrogen sulfide, since it is the primary gas evolved from sulfur which can contribute to an explosive atmosphere. Instruments of the various manufacturers may give different scale readings for any given gas concentration, so that it is important to know how the instrument is calibrated and what effect temperature has on the calibration.

NOTE: One combustible gas indicator will register 100 percent at a hydrogen sulfide concentration in air of 4.3 percent, its lower explosive limit when measured at room temperature. At the temperature which liquid sulfur is normally handled, the lower explosive limit for hydrogen sulfide in air is about 3.4 percent, and the corresponding reading on that combustible gas indicator is 70 percent. To provide a margin of safety, it is recommended that loading or handling operations be discontinued whenever reading of 35 percent in the gas space of liquid sulfur containers is indicated on that instrument. Operation should not be restarted until the atmosphere is purged with air, and the reading is 15 percent or less.

44. Operating Precautions and Equipment Design for Minimizing Hazards.

4401. In the vicinity of liquid sulfur containers, certain basic precautions should be taken to eliminate prime sources of ignition which can cause fires or explosions. The use of open flames, electric sparks and smoking shall be prohibited.

4402. Liquid sulfur storage tanks should be designed with filling lines which extend to near the tank bottom so that the incoming sulfur will enter the tank below the surface of the sulfur in the tank and thereby minimize agitation and release of hydrogen sulfide from the sulfur.

4403. Adequate steam-jacketed vents shall be installed on covered liquid sulfur storage tanks to provide natural draft venting of hydrogen sulfide gas which may be released from liquid sulfur. Vents should not contain obstructions.