

## COAL AND CHARCOAL STORAGE

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## 1.0 SCOPE

This data sheet covers loss prevention recommendations for coal and charcoal storage.

### 1.1 Changes

January 2003. Clarification regarding storage clearance was added.

### 1.2 Superseded Information

No information has been superseded by this May 2000 edition.

## 2.0 LOSS PREVENTION RECOMMENDATIONS

### 2.1 Introduction

Different construction, protection, occupancy and ignition control safeguards may apply to bituminous coal, coke, sea coal and charcoal. Recommendations that apply individually to each of these materials are found in each of the sub-sections that follow.

### 2.2 Construction and Location

For Bituminous Coal:

2.2.1 Construct coal bins, silos, or bunkers entirely of noncombustible material, preferably concrete. The structure should be roofed to keep out rain and snow, and the space above the coal should be well ventilated to prevent a concentration of gases given off by the coal. An elevated cone-shaped bin in which coal is fed at the top and removed at the bottom is recommended. This arrangement prevents fine material from collecting and remaining in the bin for long periods, and the coal at the bottom, which is most likely to be troublesome, is the first to be removed. Coal bins and, when possible, bunkers and silos should be emptied during summer shutdowns and other prolonged idle periods. Provide automatic sprinkler protection if the structure has combustible construction or occupancy other than coal. Provide access openings for manual firefighting.

For Coke:

2.2.2 Construct bins, silos, or conveyor enclosure of noncombustible material. Otherwise, provide automatic sprinklers.

For Sea Coal:

2.2.3 Noncombustible small buildings or cut-off rooms are recommended for the main storage of sea coal. Provide bins for bulk storage that are of fire-resistive construction. The quantity taken into manufacturing areas should be kept to a working minimum.

2.2.4 Provide the maximum practical amount of explosion venting on equipment, including collectors, pulverizers, and hoppers in which sea coal is processed or handled. Conveying and mixing equipment should be in dust-tight enclosures.

For Charcoal:

2.2.5 Store bulk charcoal in bins or silos of noncombustible weather-tight construction, and as small as possible to facilitate firefighting.

2.2.6 Provide ventilation in silos above the charcoal, but not below, because air flowing up through the material can cause spontaneous heating.

2.2.7 Provide explosion venting of 1 sq ft of vent area per 180 cu ft of room volume ( $1 \text{ m}^2/55 \text{ m}^3$ ) in buildings or rooms where finely divided charcoal is in air suspension or can accumulate on beams or ledges, and in bulk storage bins and silos.

**2.3 Occupancy**

For Bituminous Coal:

2.3.1 If possible, all coal should be purchased on definite specifications to secure characteristics least likely to support spontaneous heating while providing a satisfactory fuel. Sulfur content should be held to one percent and moisture content to three percent "as mined," particularly if the coal will not be used for several months.

2.3.2 Avoid storing the coal in contact with any source of external heat, such as piping, flues, boiler walls, and over steam mains, even though buried. Also avoid storage over iron or steel fire service water mains.

2.3.3 Prevent movement of air through coal. Coal should not be piled over manhole covers or covered pipe trenches that might allow air to find its way into the pipe. It should not be piled around timbers, columns, or large pipes, as air may pass along these surfaces and produce a flue effect. Do not attempt to vent a coal pile with pipes or flues, because this usually supplies more oxygen and increases the heating.

2.3.4 Check the temperature of the coal pile weekly or more frequently if heating has been known to occur. If pile temperature exceeds 160°F (71°C), open the pile and place the overheated material in a separate small pile; or use it promptly.

2.3.5 Low-grade coal should not be piled higher than 10 ft (3 m), and best-grade not higher than 15 ft (4.5 m), unless it is piled by the roll-packing method. Locate yard piles at least 25 ft (7.6 m) from other combustibles and from important plant buildings.

For Coke:

2.3.6 Quench or cool raw coke before piling out of doors or placing in silos and bins.

2.3.7 Limit outdoor piles to the smallest practical size and height.

2.3.8 Handle coke-storage fires similarly to those in coal storage.

For Sea Coal:

2.3.9 Store in a dry, well ventilated location protected against rain, snow, and surface water. Store bagged materials on skids. Locate bulk storage bins above grade.

2.3.10 Subdivide bagged sea coal into half-carload lots with 6 ft (1.8 m) aisles between. Preferably do not pile more than six bags high. Provide a 2 ft (0.6 m) space along the walls for ventilation, and to permit inspection for evidence of heating.

2.3.11 Do not store coal that shows evidence of spontaneous heating.

2.3.12 Check bags as they are unloaded from trucks or boxcars. If any are excessively warm spread them out in a single layer with space between in a dry safe location. Keep the entire shipment under observation until cooled to a safe level. Sea coal that has become wet in transit should be thoroughly dried before storing.

2.3.13 Arrange watchman's rounds so that the coal storage area is under observation at regular intervals.

2.3.14 Maintain high standards of housekeeping. Do not permit an accumulation of dust on pipes or beams where it may be dispersed in a cloud by a mechanical disturbance or a minor explosion.

For Charcoal:

2.3.15 Store packaged charcoal in a weather-tight, well ventilated building with automatic sprinkler protection.

2.3.16 If charcoal is received wet, do not store it with dry charcoal; it should be stored separately and used or dried promptly. Watch wet charcoal carefully for indications of spontaneous heating. Store all charcoal separately from oils, greases, or other combustible material.

2.3.17 At charcoal manufacturing plants, install a temperature alarm in silos or storage bins to detect spontaneous heating of freshly made charcoal. Cool charcoal in retorts for 1 or 2 days and then expose it to air for 2 to 20 days, depending on fineness, before it is shipped.

2.3.18 If a fire in bagged or bulk charcoal storage is small enough, remove the burning material to a safe location and wet it down thoroughly. If it cannot be removed, wet it down in place and remove it to a safe location as soon as possible. Do not wet down more charcoal than necessary. After all wet or burned material

has been removed, inspect the remaining material frequently and remove any found heating spontaneously. Provide ventilation for fire fighters, and for removal of carbon monoxide or hydrogen.

2.3.19 Maintain storage a minimum of 36 in. (915 mm) below sprinkler deflectors.

## 2.4 Protection

For Sea Coal:

2.4.1 Provide automatic sprinkler protection for sea coal storage areas, regardless of building construction or other occupancies. A possible exception may be detached low value storage sheds.

For packaged storage, provide protection in accordance with Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*, for a Class 1 commodity. For bulk storage, provide the same protection as specified for processing areas in Data Sheet 3-26, *Fire Protection Water Demand for Nonstorage Sprinklered Properties*.

**Note:** The duration of water demand should be increased 100% if deep seated fires can be expected.

For Charcoal:

2.4.2 Provide protection in accordance with Data Sheet 8-9 for a Class 3 commodity; if impregnated with a ignitable liquid, for a Class 4 or higher commodity as per Data Sheet 8-1.

## 2.5 Ignition Source Control

For Sea Coal:

2.5.1 Eliminate all ignition sources. Do not permit smoking, heating by salamanders, cutting, welding, or other sources of flame or embers in the storage area. Do not store sea coal near heating pipes, flues, or other sources of high temperature.

2.5.2 Necessary electrical equipment should be of a type suitable for Class II, Division 1 locations as defined in the National Electrical Code. Provide efficient spark arresters on nearby cupolas, or otherwise prevent entry of sparks into the storage area.

## 3.0 SUPPORT FOR RECOMMENDATIONS

### 3.1 Use and Handling of Coal and Charcoal

#### 3.1.1 Bituminous Coal

Bituminous coal is subject to spontaneous heating as it absorbs oxygen from the air. The heat generated by oxidation may start the coal burning, and the fire may be difficult to stop because of the large amount of fuel available and the difficulty in getting at the seat of the trouble. Anthracite is not subject to spontaneous heating.

Freshly mined coal absorbs oxygen more rapidly and is more likely to heat spontaneously than coal that has been out of the mine for some time. Heating from inherent characteristics of the coal usually occurs within 90 to 120 days after the coal is stored.

Moisture aids spontaneous heating by assisting oxidation. Water used in fighting a coal-pile fire may aggravate the trouble if it cannot reach the seat of the fire in sufficient quantity to cool it. Coal having a high moisture content should be stored separately, if possible and used promptly.

Fine coal (or coal containing much fine dust) is more susceptible to spontaneous ignition than coal that is free of such material. If coal is dropped from a grab bucket high above the pile or dumped from a trestle, many lumps will be broken, increasing the amount of fine coal. Large lumps will roll down the sides of the pile, concentrating the fine material in the center. Coal should be handled and moved about as little as possible in order to prevent breakage and the formation of unnecessary fines.

Iron pyrites (natural iron sulfide) and other sulfur compounds in coal oxidize with the liberation of considerable heat. Coal with high sulfur content is more brittle, resulting in more breakage and more fresh surface areas exposed to oxidation. Coal with as low a sulfur content as practicable is preferred. Sulfur tends to promote clinker formation when the coal is burned, and to corrode interiors of metal stacks excessively; sulfur gases combine with moisture in the upper, cooler portions of the stack and produce acids that gradually corrode the metal.

#### 3.1.1.1 Roll Packing

Roll packing helps to exclude oxygen and thus to prevent fires by discouraging spontaneous heating. It increases storage capacity in a given area about 30 percent. Coal is distributed by a grab bucket or other means in a uniform layer not over 3 ft (0.9 m) deep. The layer is then leveled by scraping, and compacted by rolling. Distributing the coal evenly avoids breakage and segregation of fine coal (Fig. 1). The firm packing helps shed water. The sides of the pile have as gentle a slope as space limitations permit. The sides as well as the top of the pile are thoroughly compacted.

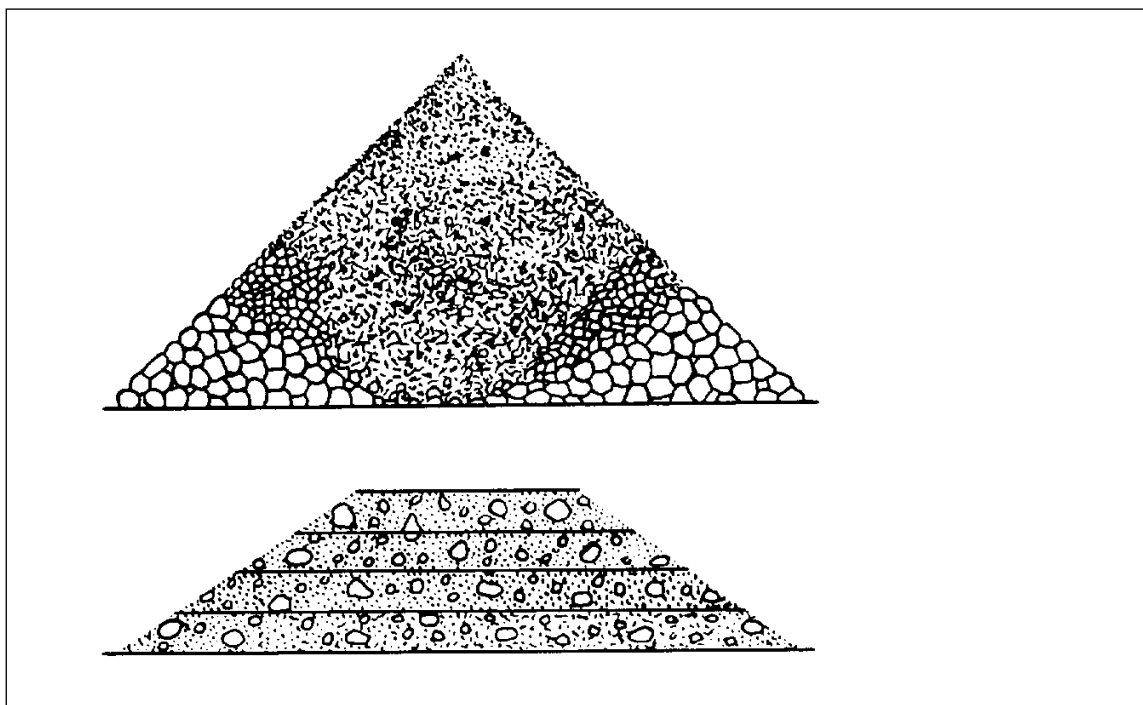


Fig. 1. Poor distribution of fine and coarse coal resulting from dumping from a high trestle or grab bucket without rolling (above), compared with a good distribution and exclusion of air by the roll-packing method (below).

#### 3.1.1.2 Checking Temperatures

Steam rising from a coal pile or the odor of burning coal are indications of spontaneous heating, but an earlier and more reliable indication is obtained by checking the temperature. This can be done by driving 1 in. (25 mm) capped piping to within 1 or 2 ft (0.3 to 0.6 m) of the bottom of the pile at points about 10 ft (3 m) apart on centers. A two-hole stopper is fitted in an ordinary test tube, and a thermometer inserted in one of the holes. The test tube is filled nearly full with water, and lowered into the pipe by a string. It is allowed to remain until it has assumed the temperature of the coal. The water prevents a rapid change in thermometer reading when the tube is withdrawn. A maximum-reading thermometer may also be used. The tops of the pipes are capped to prevent movement of air.

Thermal devices using a series of thermocouples inserted in 1 in. (25 mm) diameter capped pipes in the pile are available or may be constructed. Temperature readings are taken at regular intervals or recorded automatically; the device is arranged to sound an alarm if safe-temperature limits are exceeded. Checking temperatures in this way locates any progressive increase that would indicate spontaneous heating.

### 3.1.1.3 Handling Fires

When fire occurs, and its location and extent have been determined, the best procedure is to dig out and remove the coal in the heated zone as promptly as possible. Drench the hot coal with water as it is exposed.

Another method is to drive pointed 2 in. (50 mm) pipes, with the lower 3 or 4 ft (1 m) perforated with  $\frac{3}{8}$  in. (9 mm) holes, down into the pile. Water is then supplied through hoses attached to the upper ends of the pipes. Because of the possibility of a steam explosion, it is advisable to keep a safe distance away.

The fire will be extinguished if sufficient water can be applied to chill the burning coal below its ignition point or to cut off the air supply, but it is still desirable to remove the coal that caused the trouble in order to prevent a recurrence.

### 3.1.2 Coke

Coke, whether derived from coal or from petroleum, has little or no spontaneous heating hazard. Most reported coke fires have occurred in bins or silos at coke-producing plants. Almost all are the result of storing hot coke.

One serious fire shows the hazard in yard storage of petroleum coke. The coke was stored in a pile 100 ft (30 m) long, several hundred feet wide, and up to 60 ft (18 m) high. Hot coke was dumped onto the pile, starting the fire which spread unchecked. Eventually, the entire 180,000-ton (163-Gg) pile had to be moved, and the burning portions quenched in a pool of water.

### 3.1.3 Sea Coal

Sea coal is a commercial term for a finely pulverized bituminous coal product used in ferrous-metal foundries as a facing for sand molds to produce a smooth surface on castings. It is usually shipped and stored in paper or burlap bags, although a few large foundries manufacture their own product and store it in bulk in bins.

Sea coal is subject to spontaneous heating, and may give off flammable or explosive decomposition products. Fires from such heating have occurred both in shipment and in storage. Fires have also been caused at storage locations by sparks from cupolas, salamanders, and other outside ignition sources. A dust-explosion hazard is presented by accumulations of sea coal on beams and ledges, or where it may be dispersed in air as a dust cloud and come in contact with an ignition source.

To guard against spontaneous heating, sea coal should be manufactured only from the highest grade of bituminous coal, having less than one percent sulfur and three percent moisture, as mined.

### 3.1.4 Charcoal

The principal hazard of charcoal is its tendency to heat spontaneously, particularly when fresh and not properly cured, or if wet by rain, snow, or fire fighting. The smaller the particle size, the greater the hazard. Charcoal, because of its porosity, provides a large surface area that, with the oxygen absorbed from the air, tends to promote the oxidation of other materials such as oils and chemicals subject to spontaneous heating.

Thoroughly dried pulverized charcoal has a definite explosion hazard, the explosion intensity being somewhat less than that of cornstarch. With a sufficient period of time for charcoal powder to absorb moisture from normal atmosphere, the explosion hazard is considerably reduced, owing mostly to the greater difficulty of dispersing the material into a dust-air cloud.

During a fire in charcoal, carbon monoxide and carbon dioxide are formed, and if moisture is present, steam and hydrogen also are formed. The presence of these gases is not readily detected. Unless adequate ventilation is provided, personnel entering the storage area to work or to fight a fire might be asphyxiated or injured by explosion.

## 4.0 REFERENCES

### 4.1 FM

Data Sheet 3-26, *Fire Protection Water Demand for Nonstorage Sprinklered Properties.*

Data Sheet 8-1, *Commodity Classification.*

Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities.*

## 4.2 NFPA Standards

There is no comparable NFPA standard.

## APPENDIX A GLOSSARY OF TERMS

*Bituminous Coal:* coal impregnated with bitumen. When heated it yields considerable volatile bituminous matter.

*Bitumen:* any of various mixtures of hydrocarbons (such as tar) often together with their nonmetallic derivatives that occur naturally, or that are obtained as residues after heat-refining naturally occurring substances (as petroleum).

*Charcoal:* a dark or black porous carbon prepared from vegetable or animal substances (such as from wood by charring in a kiln).

*Coke:* residue of coal or other material (such as petroleum) after distillation and used as fuel.

*Sea Coal:* finely pulverized bituminous coal.

## APPENDIX B DOCUMENT REVISION HISTORY

May 2000. This revision of the document has been reorganized to provide a consistent format.

September 1998. Reformatted.

August 1975. Issued originally, superseding information contained in the FM Global Loss Prevention Handbook.

FMELPC June 1975