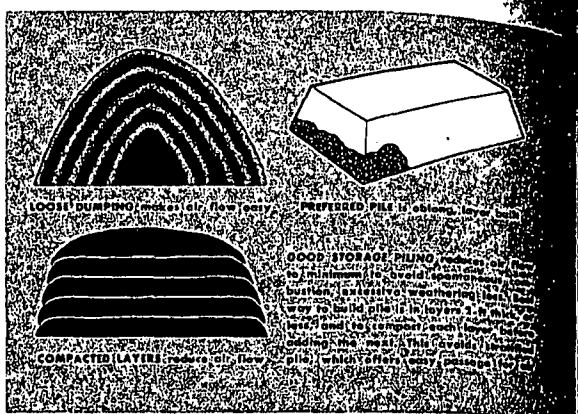
STORAGE LOSS IS SMALL

Most coals may be stored for long periods without serious loss of "quality." Tests show loss of heating value doesn't usually exceed 1% the first year, except for low-rank coals, which may lose up to 3% in first year.

Weathering tends to make most coals "slack," that is, causes a reduction in size or crumbling. Slacking is greatest for low-rank coals and near storage-pile surfaces. There is also some possibility of loss of "coking" and ignition qualities. These effects are usually negligible.

So, when it comes to outdoor storage, even for long periods, your primary concern is to guard against heating and "fires," (see below).



...safe storage depends on proper piling methods

Today, more plants than ever find it smart to stockpile coal outdoors. It's always been necessary for some — plants along waterways subject to freezups, for example. But supply and transportation dislocations during war years and strikes have led many others to follow the practice. Even aside from the emergency reserve angle, there's often sound economic sense in being able to buy coal during "off" seasons.

Safe Storage. Whether your storage is large or small, you want protection against loss by weathering and by spontaneous combustion. And if methods now well-known are used, outdoor storage, even in large amounts and for long periods, can be practical and safe.

All coals tend to combine with the oxygen of the air. Frequently this is an extremely slow process, often called weathering. There's some loss of heating value and change in firing characteristics. But if conditions are right, the action can move faster and we have heating or spontaneous combustion. Knowing what causes this is the key to avoiding storage-pile fires.

Coal-Pile Heating. When coal combines with oxygen, heat is given off. If heat isn't carried away, temperature rises. As it does, the reaction with oxygen, like all chemical reactions, speeds up. So we have a vicious circle — heat, temperature rise, faster reaction, more heat, higher temperature, still faster reaction, etc, until the coal actually burns in the normal sense.

There are two basic ways of combating this action. We *can make sure* that air moves through the pile fast enough, and uniformly enough, to carry away heat without appreciable temperature rise. Or we can try to cut air flow through the pile to a minimum to reduce possibilities of reaction.

Storing Sized Coal. What might be called the free-air-flow method is the simplest but is limited in application. Only with sized coal, which leaves more or less uniform air passages in the pile, can we depend on this scheme. In smaller plants, particularly the few remaining hand-fired ones, this works well. But larger plants rarely buy double-screened coals, and if fines are present it's necessary to use methods that cut air flow to a minimum. Let's *see why this is so.*

Avoiding Segregation. If fines are present as well as coarse lumps, we run into the problem of *segregation.* This affects other parts of the handling and firing system but right now we're concerned with its effects on storage. If, in the ordinary way, we dump coal on a pile, the fines tend to stay in the center and the coarse lumps roll to the outside. Such segregation in a coal pile gives areas or lanes where air flows readily and others where it hardly flows at all. Somewhere in such a pile, we're sure to get just the right combination of air flow and heating to produce spontaneous combustion. So the first step is to avoid segregation.

Best defense against segregation is *layer piling. To build a layered pile,* spread the coal thin over the storage area. Where coal is dumped from buckets, redistribution may be necessary. With equipment like drag scrapers, bulldozers, rubber-tired scrapers, layer piling is merely a matter of proper procedure. Even trucks can be used to build a layered pile (Power, Nov 1942, p 68). Regardless of equipment, the important thing is to build the pile in successive layers and to keep them thin — less than 2 ft, with 6 to 12 in. being best practice.

Compacting. Such piling tends to mix coal, eliminate segregation. But for troublefree storage, we'd like to pack the coal tightly to cut air flow through the pile to a minimum. Loose coal, *for example, has a density* of about 50 lb per cu ft. In ordinary storage piles, density builds up to some 58 lb per cu ft at the bottom of a 20-ft-deep pile. By *compacting,* we can raise density to 65 or 70 lb per cu *ft.*

Compacting goes naturally with layer piling. Each layer can be tamped or rolled to pack it down. Usually, weight of equipment used to spread coal proves adequate. Bulldozers and scrapers, for example, do an excellent job of compacting.

A word about coal sizing is worthwhile here. Don't compact sized coals without fines. Double-screened coals should be stockpiled separately, by the free-air-flow method. Where coal is received run-of-mine, crushing before storage is the usual practice.

Properly piled and compacted, coal stands with hard vertical walls when excavated. The pile itself is firm and hard and water runs off slopes. Yet the slopes are the weakest zone. Segregation is apt to be present in side slopes and wind can force air into sides.

Sealing the Pile. Slopes can be safeguarded in several ways. Where mobile equipment is used for piling, bulldozers should be run up and down side slopes as the pile is formed. This compacts slopes but means a relatively shallow angle, which is a disadvantage if area is limited. You can, of course, surround pile with embankments or store coal in a basin with protected sides. But this raises problems in reclaiming stored coal.

Sealing the exterior surfaces of the pile is probably the best all-round answer. Asphalt and other coating materials are used, but general practice today is to seal with a layer of fine coal, 6 in. or so thick. A carefully placed layer of coarse coal anchors the fines against wind erosion.

If Pile Overheats. A properly built and sealed pile should give no trouble, but you shouldn't just forget it. Probe the pile regularly to check temperature. If it gets up toward 160 F anywhere, you've got a bad spot. Don't try to put out the fire with water. It can stop heating only if it reaches just the right spot and is apt to cause problems of its own. Extra compacting in the heating area may cut air flow enough to throttle the reaction. But best plan in most cases is to remove affected coal without disturbing the remainder. Spreading the heated coal will usually put out the fire. Normally, it's better to use coal you salvage from an overheated area rather than try to repile it.

Some users have been successful in putting out coal-pile fires with CO_2. A pipe fitted with a well-drilling point is driven into the pile and CO_2 allowed to bleed into the affected area. If driller's points aren't available, end of pipe can be crushed and holes drilled in it. Similar methods have been used in fighting bunker fires and some bunkers have been fitted with piping and deflector plates for CO_2.

Coal Selection. Four substances seem to contribute most to the reactions involved in weathering, heating and spontaneous combustion — iron pyrites, water, oxygen and certain of the hydrocarbons. Theory says iron pyrites, water and oxygen combine to form iron sulfate and sulfuric acid in an endothermic reaction. This triggers carbon and hydrocarbon reactions with oxygen. Normally all that happens is weathering but, as we've seen, if air in the right amount feeds this reaction, and heat speeds it, we have trouble.

Today's cleaning and washing equipment at the mines removes a portion of the iron pyrites (what often constitutes the coal's sulfur content) and some seams run low in sulfur anyway. From the storage angle, this points to selecting a coal comparatively low in iron sulfides or iron pyrites. Yet it usually isn't practical to select coal from the storage viewpoint, and more often the problem is to store the coal we have or normally receive. So, in the last analysis, proper storage methods are the answer when you must stockpile coal for long periods outdoors.

WHEN YOU START TO BUILD AN OUTDOOR STORAGE PILE:

DO

Select a well-drained area for coal storage, free of standing water. Site is raised, not subject to flooding from nearby streams or runoff from adjacent ground

If well-drained area isn't available, install drainage ditches, run-length of site along the sides

If certain ground is solid, not loose and porous and not cinder If possible, grade to uniform level. Sometimes storage areas top-dressed or hard-surfaced with paving materials

Build up pile in successive layers, not more than 2-ft thick and preferably less. Wherever possible, compact each layer

Shape pile by sloping tops of successive layers and top of completed toward sides, *to prevent rain or melting snow and ice* accumulating and penetrating into the pile

Make periodic temperature checks of the pile, particularly at edges Inside slopes. Remember, 160 F is critical temperature

Seal pile as for as possible. A 6-in. layer of fines, anchored against and erosion by a carefully placed coarse layer, is good

DON'T

Never leave refuse, wood, straw, growing vegetation or any other organic material standing in an area you select for coal storage

Don't pile coal around steel or wooden posts, crane supports, etc. Pile density is bound to be lower around these elements than in the pile proper, providing vents for air and gas movement

Never attempt to ventilate a pile with pipes or wooden ducts for the same reasons you avoid piling coal around uprights (above)

Don't *store* coal near steam pipes, smoke stacks, boiler blowoff lines, heated elements of any kind

Don't just dump coal on pile. Dropped coal segregates, forming natural flues for air movement through pile

Compact unsized coal only. Sized coal stores well but not by compacting method. If you store sized and unsized, keep separate

Where you can't compact, and coal isn't sized, avoid conical piles by dumping in small continuously overlapping piles

Don't make pile sides too steep. Keep below 45 deg, with 30 deg a good slope to aim at. Steeply sloping sides risk segregation

If you locate a hot spot, or have a fire:

Cut away or isolate heated coal (2) recompact pile, starting at edges and working inward (3) if pile is small and area permits, move coal and respread it (4) try feeding CO_2 into pile, using pipe fitted with well-drilling points or with holes in flattened end

In cutting away heated coal, don't disturb remaining coal. Don't apply water to heated area. The fire may appear to be quenched after soaking, but you set up conditions likely to produce a recurrence of the heating within a very few days