The thick early spring fog was just burning off as the D9N bulldozer worked its way across the coal stockpile. The operator could see no draw hole over the feeder in front and assumed that the feeder was not on. However it was. As he trammed over the second feeder the dozer broke through a bridge and fell into a cavity, engulfed with only the top of the blade visible. Unlike more than two dozen other stockpile dozer operators since 1980, this one went home to his family that day.

Pushing coal on a stockpile is a dangerous job. When the changing stockpile conditions, time pressures, pushing coal at night and in adverse weather, and the ever present possibility of hidden cavities are considered it is easy to understand why. However, with thoughtful planning and the adoption of lesson learned the dangers can be greatly reduced.

Stockpiles provide temporary storage for coal waiting shipping or processing. The basic components are an overhead conveyor; one or more stack tubes; a conical pile of coal; an underlying tunnel with a conveyor and multiple feeders; and dozers to push coal on the surface of the pile. The dozers push coal away from the stacker cone area, creating an extended bench over the feeders which do not operate all the time.

Stockpiles are constantly changing in size and shape depending upon production levels and shipping schedules. As temporary storage stockpiles are maintained for ease of material flow into the underground feeders and often exhibit only marginal strength. Two major hazards exist: the week material around the draw hole and the possibility of hidden cavities (bridged material).

As the underground feeder removes coal a draw hole is formed. The top edge of the draw hole is very unstable and always near collapse. When a dozer is operated close to the edge it can induce a slope failure and slide down into the draw hole. Injuries and fatalities occur when the coal sloughs down on top of the dozer potentially crushing or suffocating the operator. Operators should
never push coal directly into the draw hole. They should bump it in with other coal, keeping the dozer a safe distance from the edge. The height of the stockpile determines the diameter of a cone of instability that surrounds the draw hole, as increased height widens the cone. It is good practice to keep the draw hole fairly full during feeding, however, if the operator tries to push to the surface depression created by the draw hole he is in danger of tramming over unstable coal and sliding into a depression.

For a dozer to fall into a hidden cavity three events must occur: the dozer operator must position the dozer directly over the feeder zone; second a void must have formed with the stockpile between the feeder and the surface; and third, the weight of the dozer must exceed the strength of the arched coal, the bridge, over the cavity.

Bridging begins as the usually 5 foot by 5 foot feeder at the base of the stockpile allows coal to flow. Initially only the vertical column of coal directly above the feeder moves. If the surface is either compacted due to tramming or water in the coal freezes the vertical movement stops short of the surface. The coal surrounding the column then begins to fall into the void created at the angle of repose, the steepest angle short of sliding, as the column is drawn down. This forms a conical cavity with a bridge of coal as its roof.

While the possibility of bridging due to freezing is real, the most frequent cause of bridging is compaction. The ability of coal to stream into the feeder depends upon free flow of the particles. The tendency for particles to be stuck to each other is closely linked to the distance between them and upon their size. Compaction reduces both. The danger of repeatedly tramming over an idle feeder cannot be overstated.

While much of the literature on dozer engulfment focuses on surviving, preventing it in the first place is the best defense. In 2001 West Virginia issued rule § 36-27-5.1 which outlines the minimum contents of a stockpile safety plan. An effective plan should consist of at least three basic elements: equipment requirements; entrapment rescue procedures; and, general rules and safety procedures for working on the stockpile.
Reviewing over a decade of W. Va. stockpile safety plans has identified some common core concepts. Providing gates over the feeders to ensure coal only feeds when intended, reducing unknown cavities above them. This along with marking the position of the feeders with lights and pulley mounted balls helps the operators estimate their position relative to the feeders. Flashing lights located above the feeders that are activated with the feeder provides operators additional safety information. When a cavity is detected or suspected the use of high pressure air, such as an air cannon, or water has proven effective along with a long reach excavator to breach a bridge safely.

Neither operators nor anyone else should walk on stockpiles near feeders without a safety harness connected to an overhead support and the feeders locked and tagged out. Loaders working at the margin of a stockpile should remain in a designated safety zone marked by cones or other means that ensures the any slide from the face of the stockpile will not engulf the loader.

Before entering the stockpile area, the operator should check their cab communication systems by contacting the plant operator and testing the remote stop system. The operator should check the cab to ensure all the safety equipment is there and functional. Before securely closing the cab doors the operator should check the position of the feeder markers and note if any flashing lights are activated, indicating which feeder(s) is active.

Impaired visibility often contribute to dozer operator danger, many operations have taken efforts to improve lighting for night time operations, installed water sprays to reduce dust, position operators work at dawn and dust to avoid facing the sun and taken measures for maintaining clean windshields. It has also helped that many operations now include video cameras allowing the plant operators to view the stockpile and the dozer, allowing them to react quickly to minimize harm in case the operator is in trouble.

The 2001 rule update also included §36-25.5 which outlined minimum improvements to the dozer cab for protection of those working on and near coal stockpiles. The rule required installation of a transparent material capable of withstanding 40 psi on the cabs of all mobile equipment operating on a coal stock pile. In addition it required provision of two self-contained self-rescuers (SCSRs). This provides for approximately two hours of breathable air in the event of burial. The rule required two wireless communication systems, a remote control for stopping the feeders and conveyors, emergency lighting in the cab.

These safety upgrades allowed our unfortunate D9N operator in the introduction to survive the engulfment until he could be rescued.

www.wvminesafety.org/The_Safety_Bucket/
However, the history of mine safety is written not only by responses to accidents but by the innovations in procedures and technologies by concerned miners. Many mines have gone beyond the minimum requirements set forth in W. Va. rules. Some of the former Massey operations had added additional metal supports on the interior of the safety windows further reducing the possibility of their giving way and allowing coal into the cab. Others, such as Consol Energy, have purchased some remote controlled dozers and on those manned have installed retractable stairs on the outside of the dozers to reduce the hazard of falling while entering or exiting the cab. Some Alpha Natural Resources mines are installing catwalks around the cab to allow the operator to reach fueling hoses without having to reach the ground. The availability of mats or portable bridges at some mines which can be placed to bridge a gap from stable ground to an engulfed dozer provides additional assistance if a rescue is required.

A recent stockpile dozer engulfment resulted in the rescue of the operator near the end of his second SCSR. While the rescue was successful, it pointed to a potential shortcoming in the current minimum standard. At least one mine has added supplemental breathable air to their coal stockpile dozers creating a “safe refuge” in the event of engulfment. Alpha Natural Resources’ Brooks Run Mine and ChemBio Shelter applied technology developed for emergency underground shelters in the enclosed compartments of coal stockpile dozers. The modification has been functioning for over a year at this point and several modifications have been made based upon lessons learned. The current configuration provides 24 hours of breathable air in both the model D8 and D10 Caterpillar dozers Brooks Run uses on their stockpile.

In the past too many dozer operators have been injured or died who, with our current knowledge and technology need not. The surest path to safety is to increase operator knowledge, skill and situational awareness. Ensuring that stockpile safety plans are frequently reviewed and modified based upon lessons learned is critical. Involving the operators in these reviews will not only strengthen the quality and applicability of the plans, but will improve their awareness of the dangers and the steps necessary to avoid them.

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