Step into my Laboratory, Ms. Bituminous!

"A rose is a rose is a rose," claimed Gertrude Stein. But coal varies enormously. Since such variations can determine the commercial value of the coal, laboratory testing is a key provision in the New York Mercantile Exchange's new coal futures contract.

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A friend of mine runs a steam locomotive in upper Michigan during the summer. The first year of operation, he asked me to find him a truckload of coal. I thought a nice load of East Kentucky Stoker would fit the bill. While I was making these arrangements, he found what he said was a great deal on some other coal.

"Great price!" he said proudly. "Don't bother with that expensive stuff."

The following year, my friend asked again if I could help him find some coal. "We used up all we could of the previous coal," he mentioned.

I put him in touch with several suppliers who had the East Kentucky stoker coal I thought was a good choice for him. That summer, I was able to visit the Buckley Steam Show and see the restored locomotive in action. What a beast! Oil, soot, smoke, and all. I asked the engineer how the coal was burning.

"Great! A lot better than the black dirt we had last year!" he shouted over the roar of the fire and the hissing of the steam. "There's a big pile of it over there. We basically had to fight to use it. It had tons of ash, it clinkered the grates, and we had to poke it out of the ash box," he grimaced. "The sulfur stench irritated even the toughest of the engineers."

With a big wink he threw another shovel full of coal into the fire.

These experiences of a volunteer locomotive engineer help illustrate that there are substantial differences in coals. Coals can look alike, but they may not burn the same. The amount of rock or mineral matter in coal influences the heat content, as does the amount of moisture and the type of coal. This is why coal-testing laboratories exist. Using well-documented sampling and testing procedures allows the determination of specific properties that can influence the value and burning properties of coals.

In the case of the steam locomotive, the lower cost coal saved my friend about $200 on a 20-ton truckload. Unfortunately for the steam show, the lower quality coal was virtually unusable. Yet the coal properties that caused the problems are

all measurable by coal testing labs. Should the steam show buffs use a laboratory to measure the quality of coal before they buy it? Go ask the man covered with soot and ash what he thinks.

Utilities buy coal by the barge and unit trainload. A single bargeload may weigh as much as 1,550 or more tons, and a unit trainload is often 10,000 or more tons. These loads can easily have a total value of hundreds of thousands of dollars. Should buyers of coal in this quantity make sure they know the quality of the coal they're purchasing? The coal miner works hard for his living. His productivity is measured in tons. It is a very competitive business. Can he stretch his resources and gain profit by selling dark rocks as part of the coal product? The answer is as old as the hills the coal comes from.

The company I work for has been testing coal for over 90 years. The most important step in the whole process of coal testing is getting a representative sample. But it's hard work to sample coal properly. It's not unlike trying to quantify the fish in a lake. If you wanted to know the type, size, and number of fish in a lake, you could drain the lake and count every fish. That would tell you exactly what you wanted to know but would destroy the lake. Science tells us that if you take a representative sample you could make a fair estimate. The actual sampling method would be important. Could you tell by catching one fish? Hardly. How about catching 100 fish, using worms as bait? That would tell you about the fish that eat worms. Obtaining a representative sample is hard work whether it is fish in a lake, public opinion, or a coal sample for laboratory testing.

To get a representative sample of coal for testing, it's best to sample a flowing stream of coal such as that moving on a conveyor belt during the loading of barges or railroad hopper cars. Samples of the full stream can be taken intermittently through a variety of cutters. The primary sample taken from the stream is usually a quantity of a thousand pounds. This primary sample is crushed and split by machines to produce a smaller, several-pound sample to be sent to the lab. The lab further crushes and splits the sample to produce a jar of black dust. The jar of sample coal (called 60 mesh split) is used to provide the samples used in the ovens and lab instruments.

Coal provides heat. In the United States, we measure heat using the British thermal unit or Btu. A Btu is the amount of energy that it takes to raise a pound of water one degree Fahrenheit. It is about equal to the energy in one paper match. The laboratory measures the heating value of coal by actually burning a precisely weighted portion of the sample. The preparation of this portion is critical to provide a representative split from the main sample. Then the temperature rise of a known quantity of water is measured using calibrated thermometers. The gross or higher heating value of the coal is calculated and reported in Btus per pound (Btu/lb).

The laboratory also measures the amount of moisture (water) and ash (rocks) in the coal. The water in the coal impacts the handling and dusting properties of the coal. Water also takes energy to boil away when the coal burns. The ash content of a type of coal represents inert material that causes several problems for power plants. The rocks are abrasive and cause wear in the grinding equipment. High combustion temperatures can melt some of the minerals in coal, forming slag and clinkers. The smokestacks must have the majority of the ash removed. These are just several reasons the amount of ash is important.

The amount of sulfur in coal is important environmentally. Sulfur dioxide emissions from burning coal can become a component of acid rain. The sulfur in coal is variable. Low- sulfur coals from the eastern United States are generally less than 1% sulfurous. Higher-sulfur coals are available in several regions from Pennsylvania to Missouri and fall in the range of +1% to about 4%. Many western U.S. coals are low in sulfur, and some are less than 0.5%. The sulfur in coal is usually measured by burning a representative sample of coal and measuring the amount of sulfur gases released.

These four items moisture, ash, sulfur, and Btu/lb are the primary ingredients that determine the quality of coal. There are other important physical and chemical properties of coal that the laboratory can measure. These might include tests that estimate:

Ease of grinding	(Hardgrove Grindability Index, HGI)
Ash melting properties	(Fusion Temperatures)
Combustibility	(Volatile Matter)
Handling	(Screen Sizing)

Some or all of these parameters can be critical to the proper operation of a power plant. Coal that is too hard to grind, for example, may not be suitable for certain boilers that require a specific size of coal to maintain maximum burning efficiency. Laboratory tests play an important role not only in setting the commercial quality, and hence the dollar value, in transactions, but also in allowing mining and power plant engineers to study how specific coal qualities impact the performance, maintenance costs, and durability of their equipment. Occasionally, generating companies will blend different grades of coal, depending on their power demand or marginal power production requirements.

The laboratory industry is service-oriented. Most people in the coal business would like to start their day knowing the quality of yesterday's loading. They don't want to carry the cost of a loaded barge that's unable to move until test results come in. So labs often operate at night. The primary qualities to be measured in the "short proximate" analysis set -- moisture, ash, sulfur, and heating value can be evaluated fairly rapidly. Samples collected in the afternoon will have been analyzed by the next morning. Some detailed analyses

can take longer to perform, of course, but these generally will be available within 24 hours of receiving the sample.

What does all this sampling, testing, and certifying cost?

It depends on the job. Testing a single barge of coal that needs verification of its quality and weight might cost a couple of hundred dollars. Since the value of a barge of coal may well exceed $30,000, most buyers of coal feel that independent verification of quality is well worth the investment. As the number of barges and/or the number of samples tested increases, discounts are usually applied. Some coal companies routinely check the quality of the labs they use and ask for verification of laboratory performance on blind quality control and quality assurance tests. In the industry, these are called "round robins."

One of the primary roles independent commercial labs play in the coal industry is to settle quality disputes. Almost all shipments are tested by both the coal producer and the purchaser, very often in their own labs or in labs under contract to them. Sometimes the language of the contract will dictate which lab results are to be considered definitive. When the results of these tests don't match, a third sample is often sent out, this time to an independent commercial lab whose results will provide the final judgment.

But the New York Mercantile Exchange's coal futures contract, with its time constraints, calls for a different procedure. It calls for testing by independent rather than in-house laboratories, and it allows the seller and purchaser to take the average of the two independent laboratory analyses and to call that value the final number. This avoids the delays caused by the typical industry practice of looking at the results from internal labs and then calling in a referee lab to make the final judgment. The use of two independent laboratories, as called for in the Exchange coal futures contract, with each lab using samples it collected, adds considerable reliability to quality control. By taking the average of these values, there is little ground for discussion on the quality of coal.

Until recently, most coal business was conducted between parties that had a long-established business relationship. In those circumstances, an understanding developed between the parties that allowed for the smoothing of quality issues. The Exchange's central Appalachian coal contract brings together unknown buyers and sellers, so the use of dual labs is one way to ensure that the parties will know what the actual quality of the coal is.

The principal thing to keep in mind, however, is that coal properties can vary considerably. Coal purchasers are interested in obtaining heat from coal and in causing as few performance or environmental problems as possible for the power plant. A representative sample can be taken of coal and then analyzed by a coal lab to determine the heating value and other parameters of the coal. It generally takes a large amount of coal collected in a proper way to obtain a truly

representative sample. It is important to process the coal properly to maintain a representative sample for testing in the laboratory. The information on coal quality resulting from the lab tests is used to verify the value of the coal for the buyers and sellers. Many tests can be performed that provide information critical to mining and power plant engineers. Coal testing laboratories serve the coal and power industries by providing these and other professional services.

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