The Laboratory's Role in the Coal Industry

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Introduction

Three hundred million years ago, in what we now know as the carboniferous or coal bearing age, coal had its beginnings in the vegetation of the vast, lush, swampy forests of the period.

The first records of coal mining date from about the 12th century in Europe, but it wasn't until about the 17th century that the use of coal became large scale in England. For a very long time thereafter, coal was simply burned, and no attempt was made to determine its quality relative to its value as a fuel. As its usage increased, it became apparent that some coals kindled quicker, burned with more heat, broke easier, and left more or less ash than other coals.

Utilization of coal continued, and so did the knowledge about the characteristics of various coals. The value of coals having desirable qualities was enhanced. Soon, random judgments made from personal observations were inadequate to provide the necessary information required by a growing economy which was based on the use of coal as a fuel. Thus, the coal laboratory was born.

Coal—having been formed from plant substances preserved from complete decay in a favorable environment and acted upon by various chemical and physical agencies—is not a simple substance but a complicated mixture of organic and inorganic compounds. It will never be possible to untangle the skeins of linkages and combinations of atoms in even a single gram of coal. So the coal laboratory must content itself, for the most part, with measurement of various chemical and physical generalities, such as the amount of ash formed when a coal burns or the relative difficulty or ease of grinding a coal from one size to another.

This article will enumerate and describe some of the basic tests that the laboratories perform on coal and attempt to foster a better understanding of the services a laboratory can render. Some of the common problems encountered in coal testing laboratories that are of interest to the mining industry will be discussed briefly.

A catalog of laboratory types includes:

A. Producer laboratories, those labs owned and operated for control purposes by the coal producer. These vary from the small lab performing only one or two tests, such as a quick check on ash or moisture, to the large, elaborately equipped and professionally staffed organizations of some of the major coal companies.

B. Consumer labs, those laboratories owned and operated for control purposes by the coal consumer. These also vary greatly in size, number of tests run, and so forth.

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C. Independent labs. Those laboratories are independently operated, the ownership of which has no vested interest in the coal industry in any way, other than the rendering of a coal testing service.

D. Research labs, those laboratories devoted to research in the fields of coal industry development and coal usage. These may be either producer, consumer or independent. Research facilities are often maintained by other education and government agencies such as state universities, EPA, and U.S. Bureau of Mines. Many laboratories combine a control function and research capabilities.

One of the criteria which one may use in judging the quality of an individual laboratory is the degree to which the lab is able to produce results within the precision limits of ASTM standards.

The American Society for Testing and Materials (ASTM) has developed the standards for coal testing, as well as for almost everything in our American economy that needs testing. This group is the only organization in the United States devoted solely to the development of voluntary consensus standards across a broad spectrum of industries and products. "Voluntary" means the standards are developed voluntarily by those affected and that they are used voluntarily by those who need them. "Full consensus" means that every person or organization having an interest in the standards has an opportunity to have his/her say in the technical committee. The committee is composed of individuals and/or organization representatives from producer, consumer and general interest groups.

The particular committee that has jurisdiction over coal and coke is D-05, and the Standards mentioned in this article may be found in Part 26 of the *Annual Book of ASTM Standards*. Further information on the role of ASTM may be obtained by writing ASTM, 1916 Race Street, Philadelphia, PA 19103.

The following tests are the common ones performed by the laboratory:

Moisture—The most elusive constituent of coal that the laboratory tries to capture is the moisture content. Coal, even when it appears dry, contains moisture ranging from 1 or 2% in bituminous coal to 45% in lignite.

The ASTM D-05 definition for *total moisture* has recently been revised and reads as follows: Total moisture in coal is that moisture determined as the loss in weight in an air atmosphere under rigidly controlled conditions of temperature, time and air flow as established in Methods D3302. A detailed discussion of the procedure and precautions contained in D3302 would be too lengthy for this article, but persons interested in further study of sampling and specific testing methods for this test and other tests are referred to the current book of ASTM standards, Part 26.

Inherent moisture in coal is that moisture existing as a quality of the coal seam in its natural state of deposition and includes only that water considered to be a part of the deposit, and not that moisture which exists as a surface addition. We must limit our consideration in this article to total and inherent moistures, but there are a number of other terms relating to moisture in coal, the distinctions of which the serious student may wish to pursue. These terms include: bed moisture, equilibrium moisture, air-dry moisture loss, free moisture, water of hydration and others.

Ash—The ASTM D-05 definition for coal ash is the inorganic residue remaining after ignition of combustible substances, determined by definite prescribed methods. This definition is followed by two notes, one of which states that ash may not be identical—in composition or quantity—to inorganic substances present in the coal before ignition. The second note specifies that in the case of coal and coke, the methods shall be those prescribed by ASTM D3174. This method determines the ash content by weighing the residue remaining after the coal is burned under rigidly controlled conditions of sample weight, temperature, time and atmosphere.

The definition of ash content used in other countries is similar to the American definition, but the ashing conditions may be different. Therefore, it is desirable to spell out the conditions used, particularly when the results from laboratories in different countries are to be compared.

During the burning process, various chemical and physical changes take place. The number and the extent of such changes are determined by the conditions of oxidation; thus, a great degree of variability can be expected in separate determinations of ash content even on portions of the same sample of coal unless standardized procedures are closely followed. In particular, this is true of coals with relatively large amounts of carbonates and/or pyrite.

We usually consider ash as the product of complete oxidation of coal. It is composed of the oxides formed from the mineral constituents of coal. However, these minerals may be present in two forms in coal: as visible impurities, or as minute impurities so finely divided and so intimately mixed that they may be considered a part of the coal structure.

The term "inherent or fixed ash content" is used to designate that portion of the ash content of a coal that is structurally part of the coal and cannot be separated from it by mechanical means. This is a relative term, however, and will have different values, since mechanical separation is accomplished at varying levels according to the size consist of the coal.

In general, when we hear the term "inherent ash", we assume that it means the residue that remains after coal has been broken to the size at which it is to be used, cleaned by a mechanical process and incinerated. The determination of ash content is probably the first test developed for coal and continues to be one of the most important.

Volatile Matter—The ASTM definition of volatile matter is those products exclusive of moisture vapor given off during thermal decomposition as a gas or a vapor by a material such as coal.

Volatile matter is determined by definite prescribed methods which may vary according to the nature of the material, but in the case of coal and coke, the method has been described in Method D3175.

Temperature and time are a vital concern in this test, since they actually determine the definition of volatile matter. Temperature must be 950°C ± 20°C, and heating time must be exactly 7 minutes.

The main constituents of volatile matter of coal are hydrogen, oxygen, carbon monoxide, methane and other hydrocarbons, and that portion of moisture that is formed during thermal decomposition of the coal substance.

The main constituents of volatile matter in all ranks of coal are hydrogen, oxygen, carbon monoxide, methane and other hydrocarbons, and that portion of moisture that is formed by chemical combination during thermal decomposition of the coal substance. The composition of volatile matter varies greatly for different ranks of coal.

This is one of the most important determinations in coal analyses, because volatile matter, when determined according to the conditions of this test, is used to establish the rank of coals, to indicate coke yield on carbonization processes and to provide the basis for purchasing and selling and to establish burning characteristics.

Because of the arbitrary nature of this test, caution must be used in comparing the results of volatile analyses with those obtained from tests run in other countries. Details of the various national standards vary greatly.

Proximate Analysis—This is one of those terms used by the industry about which there is a good deal of confusion. The terms in use are 'proximate analysis', 'short prox', and even occasionally (heaven forbid) 'approximate analysis'.

ASTM defines proximate analysis in coal and coke as the determination, by present methods, of moisture, volatile matter, ash and fixed carbon. The fixed carbon is a calculated figure obtained by subtracting from 100 the sum of the percentages of moisture, volatile matter and ash.

Common usage in the field seems to favor 'short prox' as the determination of moisture, ash, Btu, and sulfur; and 'prox' as moisture, ash, volatile matter, fixed carbon, Btu and sulfur. The latter term also may include fusion temperature of ash and FSI. It is advisable to get the users' definition of these words since they are not defined in the standards.

Btu Value—Even though we are adopting the metric system of measurement in the United States, in the coal industry one more often hears the term 'Btu value' (British thermal unit) than 'calorific value'. Whatever the system of nomenclature, measurement of the gross calorific value is the most important single test that a laboratory performs for coal producers and coal consumers in the steam coal market, since price is usually determined by calorific value.

Gross calorific value of solid fuels is defined as the heat produced by combustion of unit quantity at constant volume in an oxygen bomb calorimeter under specified conditions. The most common type of bomb calorimeter in use today is the adiabatic bomb calorimeter, and the ASTM standard which covers this test is D2015.

Total Sulfur—Sulfur in coal occurs mainly in three forms. It can be present in organic combination as part of the coal substance; it can be present as the sulfide ion in pyrites and marcasite; or it can be present as the sulfate ion. Rarely, sulfur may occur as elemental sulfur, but in insufficient quantities to be appreciable.

In today's market, measurement of sulfur content is of vital importance, and laboratories are often hard pressed to perform accurate measurements in minimum time periods.

Two methods are generally accepted for total sulfur determination. One is the time honored Eschka's method: this method converts all the sulfur present in the coal to the sulfate ion, which is then precipitated as $BaSO_4$. The Eschka's method requires a time period —including sample preparation—of up to 24 hours, so a more rapid method of high temperature combustion has been adopted. Details and analytical procedures for both of these methods, as well as the bomb washing method, an alternate third method, may be found in the ASTM standards D3177.

In addition to a determination of total sulfur, some laboratories offer a breakdown of the forms of sulfur in coal; i.e., organic sulfur, which is normally not over 3%; sulfate sulfur, which is rarely more than a few hundredths per cent; and pyritic sulfur, the percentage range of which varies widely.

Fusion—ASTM standard D1857 is the method for measuring fusibility of coal ash. This test is an observation of the temperatures at which triangular pyramids or cones prepared from coal ash and coke ash attain and pass through certain defined stages of fusing and flow when heated at a specific rate in controlled, mildly reducing, and where desired, oxidizing atmosphere.

This method is empirical, and strict observance of the requirements and conditions is necessary to obtain *reproducible* temperatures and to enable different laboratories to obtain concordant results.

Four stages of fusion temperature are usually reported:

- Initial, or the first rounding of the cone
- Softening, when the height has diminished until it is equal to the width at the base
- Hemispherical, when the height of the cone equals one-half the width of the base
- Fluid, when the cone is no higher than one-sixteenth inch.

The test for fusion temperatures may be run in either a reducing or an oxidizing atmosphere.

FSI—Free swelling index or coke button test is another test which is usually accorded by the uninitiate more credence than it deserves. It is a small scale test for obtaining information on the free swelling properties of a coal.

The test, covered by standard D720, consists of burning a one gram sample of coal in a covered crucible under specified conditions of temperature and time. The button formed is compared to a series of standard profiles. This test is not recommended as a method for the determination of expansion of coal in coke ovens. It is often used as a quick, rough check of whether or not a coal is oxidized.

Grindability—This test determines the relative ease of pulverization of coal in comparison with coals chosen as standards. The Hardgrove method has been accepted as the standard, and D409 is the Standard Method for Grindability of Coal by the Hardgrove Machine.

Each Hardgrove machine is calibrated by use of standard reference samples of coal, having grindability indexes of approximately 40, 60, 80 and 110. Standard coals may be obtained from the U.S. Bureau of Mines in Pittsburgh for the purpose of calibration.

The Hardgrove index number reported by the laboratory is based on an original soft coal chosen as a standard coal whose grindability index was set at 100. Therefore, the harder the coal, the lower the index number.

Since the grindability index varies, not only from seam to seam, but within the same seam, grindability data is of utmost economic importance to the users of commercial grinding equipment.

The results of grindability measurements by the Hardgrove machine are affected by several factors, among them the ash and moisture content, temperature, and the presence of different petrographic constituents (organic components distinguishable by microscopic inspection). Moisture content is particularly troublesome in low-ranked coals, and a new standard is being prepared for lignites and sub-bituminous coals.

Size Consist or Sieve Analysis of Coal

The tests that cover the separation of coal into the various screen and sieve sizes are: D410, Method of Sieve Analysis; D431, Designating the Size of Coal from its Sieve Analysis; and D311, Sieve Analysis of Crushed Bituminous Coal. These methods apply to all coals except anthracite, which is covered by D310, and certain prepared coals used in boiler plants, and crushed coals as charged into coke ovens.

Provision is made for drying the coal before separation into the various sizes, and therefore, these are dry sieving methods. Substantially different results may be obtained on the same coal if it is sized while saturated with water. With modern methods of coal handling and preparation, coal very often is in a wet condition or possibly used as a slurry, and the size composition results more accurately reflect operations conditions if the sieve analysis is done by washing the coal through the sieves with a stream of water. Many laboratories are using wet sieving procedures, but no ASTM Standard Method exists; however, a D-05 subcommittee is currently engaged in writing such a standard.

The above tests are the ones most commonly performed by the small laboratory. Increased demand for coal and more sophisticated requirements from consumers, especially in the metallurgical market, have increased the use of a number of more or less exotic tests on coal. Many laboratories now offer one or more of the following services:

Ultimate Analysis of Coal—is a term which expresses the composition of coal in precentages of carbon, hydrogen, nitrogen, sulfur, oxygen and ash, regardless of their origin. For instance, the carbon is all the carbon that is present in coal, and the hydrogen figure includes the hydrogen in the coal substance as well as that in the moisture content.

In this analysis, tests are run to determine carbon, hydrogen, nitrogen, sulfur, oxygen and ash in accordance with the appropriate ASTM standard, and the oxygen is calculated by subtracting from 100 the sum of the other components.

For those interested in pursuing further study on this test, the ASTM standard number is D3176.

Analysis of Coal Ash—There are many elements present in coal other than carbon, hydrogen, nitrogen, oxygen and sulfur. When coal is burned, these elements—generally in the form of their oxides—are left as an incombustible residue which we call ash. We cannot completely separate the mineral matter of coal by any physical method to completely identify the individual minerals or to determine them quantitatively. Therefore, to assess the amounts of the major elements present in coal, an analysis is made to determine the percentages of the oxides of these elements present in the coal ash. ASTM method D2795 covers a rapid and relatively inexpense method for determination of the following:

silicon dioxide	calcium oxide
aluminum trioxide	magnesium oxide
ferric oxide	sodium oxide
titanium dioxide	potassium oxide
phosphorus pentoxide	

Many other elements are present in small amounts in coal ash. There have been a number of studies done on these minor constituents, and a task group in ASTM is currently working on standard method of analysis for trace elements in coal.

Plasticity or Fluidity—When a coal is heated, two things occur: the volatile materials are expelled, and the remaining solid residue softens and becomes more or less plastic. The coal particles cake to form a bubbly, compact mass which swells and then re-solidifies to form a solid, coherent body with a porous structure called coke.

One of the tests devised for studying the behavior of coal while heating is the FSI or coke button test discussed earlier in this article. This test is quite popular since it is rapid and easily reproducible under standardized procedures. However, the information obtained is scanty. Actually, the only real information obtained is whether or not a coal is non-caking, weakly or medium caking, or strongly caking.

Other instruments and testing procedures have been developed to measure physical characteristics of coal.

Plasticity or fluidity of coal has come into a good deal of prominence recently. The plastometer is an instrument which measures the plastic properties of coal by the use of a constantly applied torque on a stirrer placed in a crucible charged with coal. The crucible is immersed in a bath, and the rate of temperature increases uniformly. The rates of movement in the stirrer are recorded in relationship to the increase in temperature. This test gives a semi-quantitative evaluation of the plastic properties of coals and blends used in carbonization and in other situations where determination of the plastic behavior of coal is important.

Test results are reported as follows:

- Initial softening temperature, or the point at which coal shows first softening, measured when dial movement reaches 1.0 dial divisions per minute
- Maximum fluidity temperature, at which the dial movement reaches the maximum rate
- Solidification temperature, at which the dial movement stops
- Maximum fluidity, or the maximum rate of dial movement in ddpm

There are two ASTM methods for this test: D1812, Plastic Properties of Coal by the Giesler Plastometer; and D2639, Plastic Properties of Coal by the Constant Torque Giesler Plastometer.

A question commonly asked laboratory technicians by customers who are becoming aware for the first time of the importance of this test in the metallurgical market, is: "How many DDPMs makes a good plasticity?" The best answer to this question is "I don't know," or "A good plasticity DDPM figure is the figure that the purchaser needs for his particular purpose." A charge going into a coke oven will commonly have a fluidity range of 6,000 to 12,000 ddpm, but many coals are used as components of blends in carbonization. The laboratory technician is not qualified to interpret results obtained on this test relative to the purchaser's need, since he generally knows nothing about the fluidity desired by a particular user or the other coals the user may wish to use for blending.

ASTM standards are based on the Giesler Constant Torque Plastometer, but there are also variable torque plastometers, such as Davis Braybender and Cerchar types.

Another device which is utilized for measuring or characterizing plasticity is a pentrometer which records the penetration of a metal needle as a function of temperature rise. Still another measurement of plastic properties is made by use of a dilatometer, which is an instrument that records the variations in the length of a cut piece of coal or a pencil made of pulverized coal heated at a definite rate. A commonly used dilatometer is the Audibert-Arnu dilatometer.

This test is quite popular with coal users in western Europe. Test results are reported as follows:

- Initial softening temperature
- Initial dilation temperature
- Maximum dilation temperature
- Contraction percentage
- Dilation percentage

There are other types of dilatometers, among them the Chevenard-Journier, Sheffield & Hoffmann dilatometers.

Plastic properties vary considerably from one coal to another. There seems to be some correlation between fluidity and volatile matter and a better one between fluidity and ash-free carbon content. But, the effect of oxidation on fluidity is unmistakable. In general, oxidation causes an increase in the softening temperature and a lesser decrease in the re-solidification temperature. Intense oxidation can decrease the plastic range to zero. Some coals are more affected than others, but in any case, when a sample is transported to the laboratory for plasticity tests, care should be taken to protect the sample from oxidation.

Washability—Economic considerations loom large to both producer and consumer in determination of the extent to which coal can be subjected to a cleaning process. The rapid growth of coal preparation plants has been due to a number of factors, including increased emphasis on production, environmental problems and the ever-decreasing supply of low ash and low sulfur coal, as well as new methods of mining like large scale stripping and augering operations. It is of paramount importance that a preliminary investigation be made of the washing characteristics of a coal before large sums of money are spent to build coal cleaning plants.

The laboratory performs the function of treating a sample of coal to a process which simulates the one it would receive in the coal washer by floating the coal in organic solvents of increasing specific gravity, then analyzing the portions that float at these gravities and the portion that sinks in the final separation.

Care should be taken in assembling the gross sample to be sure that it is representative of the coal produced by the mine and that it is large enough to conform to the standards of ASTM in order to achieve reasonable accuracy. Often the size of the sample is measured in tons, especially if larger sizes are to be cleaned. It is difficult for the novice to comprehend that such large samples are necessary. The temptation is always toward an inadequate sample, since the gross sample cannot be reduced prior to the float and sink testing. Because there is no ASTM standard method for washabilities as yet, when the coal is delivered to the laboratory the customer should remit his instructions in writing as to how he wishes the coal subdivided and the specific gravity of the solutions to be used.

The washability characteristic of a coal is the most important tool available to determine the extent to which a coal may be cleaned. Examination of washability data for a particular coal or a particular size of coal will reveal the quality of coal which may be obtained by mechanical cleaning, as well as the quantity of coal of a particular quality. Further examination of the data will indicate the ease or difficulty with which the coal may be cleaned and will give valuable information concerning the type of commercial cleaner most suitable for that particular coal.

The ash, sulfur or Btu specifications of all of the final product generally dictate whether or not cleaning is necessary. After technical considerations are evaluated with the help of washability characteristics and if the cleaning is technically sound, then the economic decisions are made. These considerations include the value of the final product and the cost of obtaining it. Cleaning may be necessary to meet specifications or to make a higher grade product with increased financial reward.

Washability data is also used to determine the efficiency of a cleaning plant. The efficiency of a plant operation or any operation of a particular cleaning process being used in the plant is simply a measure of the actual results compared with the theoretical. It must be emphasized that the laboratory uses organic liquids of different specific gravities; however, these organic liquids cannot be used in commercial operations because of the high cost. Instead, other methods such as suspensions of finely divided solids are added to water to prepare a suspension of the specific gravity needed. Therefore, it is not expected that the various methods used to clean coal in cleaning processes will result in a product exactly equivalent to that produced within the laboratory, since the lab result is presumably a 100% efficient separation.

Float and sink separation is quite effective for determining the washability characteristics of course coal, but the problems associated with cleaning of extremely fine sizes dictates o'her methods. Froth flotation is an increasingly important method for cleaning fines. The process consists of passing air through a suspension of fine coal in water. The coal particles attach themselves to the air bubbles and are removed in the froth on top of the pulp. The refuse particles remain in the pulp. Chemicals are added to the pulp to help produce the froth.

Although washability data may be used to determine the quantity and the quality of the coal theoretically possible from a flotation process, a more realistic method has been developed. This method consists of splitting up the original flotation froth into several fractions and refloating the fractions two or three times. Each refloating fraction is then analyzed to determine the quantity and quality of the products. In actual plant operation, the first float is referred to as a 'rougher' operation, and the subsequent flotations as 'cleaner' and 'recleaner' operations. The cleaning and the recleaning are required at times to meet specification grade. Additional methods of fine coal cleaning, such as reverse flotation, are currently being developed to obtain even greater refinement of the end product. Laboratory methods for froth flotations are a scaled down process of the flotation itself differing only in that the laboratory works on a batch of coal and the commercial flotation is a continuing process.

Washability studies can also be done on drill cores, enabling the coal producer to evaluate his reserves and plan future production in terms of the possible need and the most desirable equipment for coal cleaning.

These tests by no means exhaust the services provided by coal laboratories. ASTM also has standard methods for such tests as Carbon Dioxide in Coal, Chlorine in Coal, Equilibrium Moisture, Drop Shatter Tests, Microscopial Analysis by Reflected Light, Expansion-Contraction by the Sole-heated oven, and others. Not all tests, of course, are run by every laboratory.

Since the advent of the regulatory agencies such as EPA and OSHA, both the coal producer and consumer have need of testing services to measure the impact on the environment of the processes used in producing or using coal. Many laboratories now offer services in the fields of water testing, air quality studies and soil analysis. In water testing, the number and kinds of tests required of the mining industry and its consumers by the Environmental Protection Agency may be different for different companies, depending upon the particular conditions encountered in each case. Laboratories offering water tests may have capability of testing 100 or more parameters. However, the tests commonly required by the various state governments for mine drainage permits are: pH, Alkalinity, Total Acidity, Mineral Acidity, Iron, Aluminum, Manganese, Sodium, Sulfate ion, Chloride ion, Suspended Solids and Dissolved Solids.

These, then, are some of the services coal laboratories render. As in all service businesses—indeed, as in all businesses of any kind—there are common problems. A short discussion of laboratory problems may be of interest to the consumer, and an understanding of the factors involved may be of mutual benefit to both parties.

Probably the most persistent concern of the lab is proper sampling. Whenever possible, the laboratory likes to supervise the sampling process. Unless a sample is taken with strict adherence to scientific principles of selection, the laboratory analysis may be technically correct but useless, since it may not truly represent the lot of coal sampled. The sampler, whoever he may be, should be intimately acquainted with ASTM standard D2013, Preparing Coal Samples for Analysis. The need for proper sampling cannot be over-emphasized.

Another problem the laboratory faces is the customer who wants his work done day before yesterday. Unfortunately, laboratory work is not instantaneous. Like the proverbial, non-existent "safe, fast airline pilot", there are no accurate, super-fast laboratories. The customer must realize that if he demands super speed, he will inevitably sacrifice accuracy. One factor of importance to be considered is the time involved in drying the coal sample. Care must be taken to lower the moisture level using temperature and time rates that do not oxidize the coal. Excessive heat during drying will drive off part of the volatile matter and consequently, will lower the Btu value of the coal, as well as contribute to false values in each test where moisture content is included in the calculation of reported values. Labs will usually be glad to discuss the time periods involved in each test and give considerations to special needs for speed on special occasions. It is to be hoped that the client will not make every sample a special occasion.

Accuracy levels are a continuing source of misunderstanding between client and laboratory. The problem usually stems from an exaggerated idea on the part of the client of the precision capability inherent in the laboratory test. Modern technology has accustomed the American public to expect miracles in minute measurement, but it must be remembered that coal is not a simple substance—it is a complicated combination of organic and inorganic elements and compounds, and most of the tests run on coal and coke are necessarily of an empirical nature.

Precision statements are included in most of the ASTM methods. These include repeatability statements which are the difference levels not to be exceeded in duplicate determinations carried out in the same laboratory by the same operator using the same equipment, and reproducibility statements, which cover the mean of results of duplicate determinations carried out by different laboratories on different portions of the same sample.

Some knowledge of the precision possible in coal testing is useful to the customer in analyzing the data presented to him by different laboratories. Occasionally the laboratory encounters persons who expect precision to the second decimal place on different samples of a lot of coal. A word of caution concerning the ASTM precision statements must be given. These statements refer to permissible differences in repeatability or reproducibility on portions of the *same* sample. Precision on different samples of the same lot of coal is a different and more complicated matter.

Ethical considerations are basic to a laboratory's function. Opportunity for nefarious practice is more than ample in the testing field. Laboratories engage in the sale of information, and unless that information is both accurate and honest, it is useless. The ideal laboratory is one where accuracy and integrity are of equal importance, and the client should take both into consideration in choosing his lab.

The Federal Register, Vol. 40, #90, dated 8 May 1975, carried the proposed procedures of the U.S. Department of Commerce National Voluntary Laboratory Accreditation Program. Laboratory accreditation has been needed for decades for the protection of the user of test data, as well as for the protection of the laboratory from unwarranted liability. This program will be an over-all accreditating program which will reduce the need for the many overlapping, partial programs currently in use.

The stated purpose of a National Voluntary Laboratory Accreditation Program is to serve, on a timely basis, immediate needs and also to establish a background of experience necessary to the orderly evolution of an accreditation program to serve national needs as they develop. The goal of this program is to provide a national voluntary system to examine the technical competence of private and public testing laboratories that serve regulatory and non-regulatory product evaluation and certification needs and to accredit those laboratories that meet the qualifications established pursuant to those procedures. This program will also require those laboratories that are accredited to maintain an acceptable level of competence, and thus assure national interests that such capability is available.

Many laboratories have already been moving toward accreditation standards, using guidelines developed by such organizations as ASTM and the American Council of Independent Laboratories (ACIL) and have much of the groundwork done on the road to accreditation.

"Today's laboratories offer the mining industry an absolutely infallible measure of coal quality!" Wouldn't it be wonderful to be able to make such a statement? Unfortunately, there is no one in the coal business or the laboratory business who would believe you, and rightly so. The laboratory is a tool. Used correctly, it can supply a wealth of information enabling the modern coal producer and consumer to utilize this precious and finite natural resource in the most efficient way possible. Used carelessly, dishonestly or incompetently, it becomes a weapon or a flim-flam, a source of contention and a stumbling block to progress.