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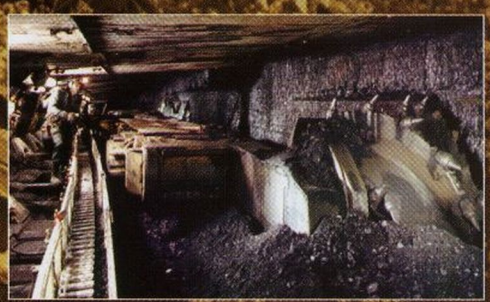
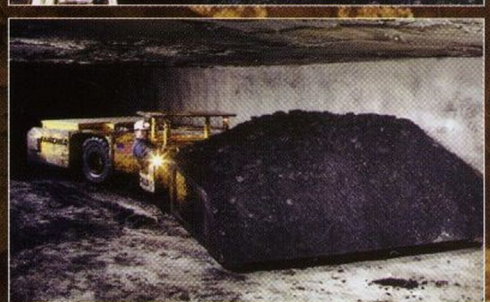
ASTM Committee D05 ON COAL AND COKE

100 Years of Standards Development





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CELEBRATING 100 YEARS OF SERVICE TO THE COAL INDUSTRY

BY LOUIS C. G. JANKE, JAMES A. LUPPENS, AND RONALD D. GRAHAM

on Coal and Coke

Have you ever wondered, "What is the power behind the light switch?" A recent informal survey indicated that few people interviewed really have a reasonable concept of what powers the United States' electric utility industry. When it was explained that the United States still depends heavily on coal for electricity, a common reply was, "We still burn coal in this country?"

Do you know what percentage of the United States' electricity is produced from coal? Do you know which state ranks first in total coal consumption per year? Can you name the top five states in terms of coal production?

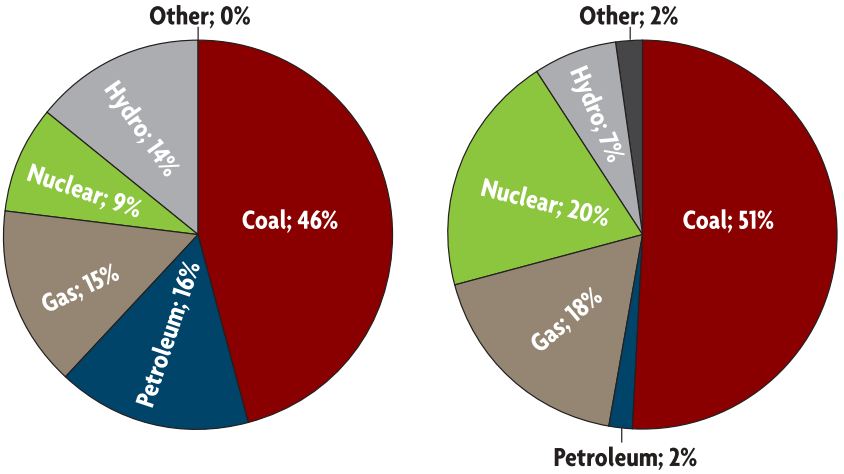
Some of the answers may surprise you. First, how much coal is actually used in the United States to generate electricity? From 1976 to 2002, electricity generated from coal actually grew from 46 percent of the nation's total electrical output to 51 percent (see Figures 1 and 2).

The next surprise is in coal utilization. Texas, which has been synonymous with oil and gas, is the biggest user of coal, ranking first among the states in total coal consumption at over 99 million tons [90 x 10^6 metric tons or 90 teragrams (Tg)] per year. In consumption, Indiana follows Texas at 69 million tons [63 Tg].[1]

Finally, based on 2002 statistics (in millions of tons), the top five states ranked in order of total coal production were Wyoming (373.5 [338.8 Tg]), West Virginia (150.6 [136.6 Tg]), Kentucky (123.4 [111.9 Tg]), Pennsylvania (68.7 [62.3 Tg]), and Texas (45.2 [41.0 Tg]).[2]

Energy from coal is the answer to the very first question, "What is the power behind the light switch?" Energy from coal powers lights, recharges electric car batteries, runs elec-

Figure 1: Percentage of electricity by fuel type, 1976 and 2002[5]



1976 Generation of Electricity **2002 Generation of Electricity**

tric shavers and hedge trimmers, turns on computers, and drives our assembly lines. Coal is what we take for granted every time we flip a switch.

THE U.S. COAL INDUSTRY

It is estimated that the United States possesses 25 percent of the world's known accessible and minable coal reserves,[3] making it the "Saudi Arabia" of coal. With an average production on the order of 500 million tons [450 Tg] per year, coal served as an integral component of the U.S. gross domestic product from 1900 to the1950s. Although it is not well known, production through the later decades of the 20th century on into the new millennium skyrocketed to near 1.1 billion tons [1000 Tg or 1 x 10^9 metric tons] a year to help meet U.S. domestic and industrial energy demands (see Figure 2).

Current U.S. energy consumption is on the order of 98.1 quadrillion Btu [103.5 x 101^8 joules or 103.5 EJ] per year. With production of over 1 billion tons [900 Tg] a year, coal supplies 22.7 quadrillion Btu [23.9 EJ] or about 23 percent of all U.S. energy needs.[4] To put this in perspective, current coal production is sufficient to operate the equivalent of about 420 power plants (750 megawatts each) 24 hours a day. Coal is a critical component for manufacturing steel and cement, the two greatest elements of the U.S. infrastructure. Coal is also used to generate over 50 percent of all electricity the United States produces today. Without coal and a thorough understanding of its chemistry and uses, the United States would not have achieved and could not sustain its present status as the wealthiest, most heavily industrialized nation on earth.

Most of the valuable coal seams in the United States originate from two main geologic periods. The valuable Appalachian Basin bituminous coals, which include almost all of our metallurgical grade coals, originated from swamps formed some 270 to 350 million years ago, before dinosaurs roamed the earth. The lignite and sub-bituminous coals of the western United States, including the vast reserves of Powder River Basin coals, originated some 45 to 65 million years ago, on the heels of the dinosaurs' extinction.

The development of U.S. coal reserves goes hand-in-hand with the industrial revolution. Prior to the 1890s, wood was the dominant source of energy. In the early 1900s, energy consumption from coal, a more concentrated and consequently more efficient source of energy, surpassed that from wood, and this fact greatly accelerated the development of the economy. Coal production paralleled U.S. productivity, decreasing dramatically during the Great Depression and recovering only with the beginning of World War II. In 1917, 33 million tons of coal [30 Tg] were burned annually. Today, that figure is over 830 million tons [750 Tg]. Coal consumption by the steel and cement industries, which was 3.34 million tons [3.03 Tg] in 1880, stabilized at 79.3 million tons [71.9 Tg] in 1951.

During the past 100 years, ASTM International has developed a world-class standards development forum that has allowed Committee D05 on Coal and Coke to work in concert with the coal industry worldwide to implement standards that have provided significant technological, economic, and productivity benefits. These standards have played a pivotal role in driving the U.S. economy to its preeminent position in the world today. Current estimates forecast that the U.S. coal resource base could supply an integral component of energy demands for at least another century; there will be a continued need for ASTM standards that promote the effective utilization of coal.

DEVELOPMENT OF ASTM COMMITTEE D05

To promote the growth and sustain the vitality of the U.S. coal industry, ASTM Committee D05 has worked hand-in-hand with the coal, utility, and steel industries to establish standards for the sampling, preparation, and testing of coal. The ASTM Committee on Coal and Coke, designated as D05, was formed in 1921 as a merger of three separate groups: Committee J on Standard Specifications for Foundry Coke, which had been formed in 1904; Committee O on Standard Specifications for Coal; and Committee E04 on Sampling and Analysis of Coal.

Joseph A. Holmes, who was instrumental in getting the U.S. Congress to establish the U.S. Bureau of Mines in 1910, was the first chair of Committee O. Committee E04 worked jointly with the American Chemical Society to develop standard methods for the proximate analysis of coal under the chairmanship of Professor Samuel W. Parr and W. A. Noyes. A. C. Fieldner was the first chair of D05 and served continuously in that capacity from 1920 until 1948.

Since the 1921 merger, D05 has worked diligently to promote a defined focus and purpose. The growth in membership from around 60 to over 200 today coincided with the rapid growth in productivity of the coal industry. The Committee currently has jurisdiction over 70 standards. These standards have played and continue to play a preeminent role for the effective industrial utilization of coal from all regions of the United States for both electricity and metallurgical coke production.

As coal production increased through the 20th century, the need for

uniform, rapid, efficient, and reliable practices for coal assessment became a critical factor in the marketplace.

D05 DEVELOPS WITH THE COAL INDUSTRY

Around 1920, the first pulverized coal fired boiler was developed. Steam generator sizes expanded rapidly; the first pulverized coal unit capable of producing 1,000,000 pounds of steam per hour [284 megawatts (MW)] was brought on-line in 1929. In 1966, a unit was installed at TVA's Bull Run Station capable of 6,400,000 pounds of steam per hour [1820 MW], serving a turbine capable of producing 900 MW. To meet the increased capacity demands of larger and larger steam generators, ball mills were introduced in 1933. To optimize the use of this new technology, a new test method, ASTM D 409, Standard Test Method for Grindability of Coal, was developed by D05 for determining the ease of mill throughput.

In 1927, due to the existence of many coal seams of economic interest and of varying nature, a joint committee of ASTM and the American Standards Association was formed for the classification of coal. This combined group was responsible for the production of ASTM D 388, Classification of Coals by Rank, originally published in 1934. The standard is accepted worldwide as the reference standard for coal classification. During the 1960s and 1970s, Committee D05 introduced terminology standards for the description of coal seams. Further intensive efforts from the late 1970s to the present day have resulted in improvement of these terminology standards and the development of practices for the collection of coal samples, the latter culminating in the publication of an ASTM Special Technical Publication on core sampling in 1990 (see Figure 3). This effort prompted the development of more comprehensive and effective standards for the determination of total and bed moisture in coal. Collectively, these initiatives have provided a uniform and reliable basis for the classification of coal reserves.

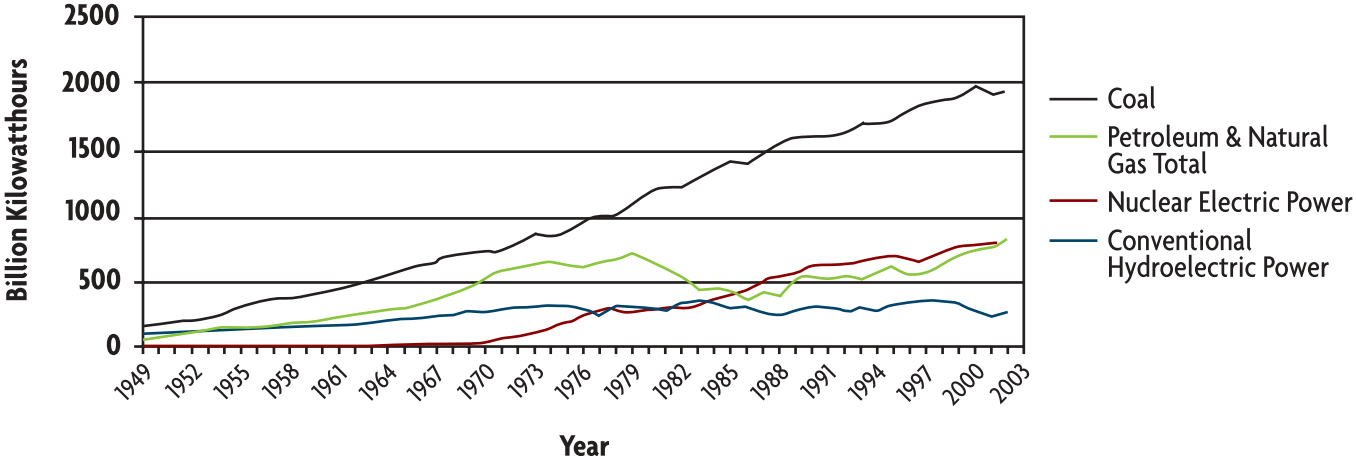
In 1950, in conjunction with the Edison Electric Institute, D05 commenced a decade-long study on coal-sampling methods. In 1962, this major effort resulted in the publication of D 2013, Standard Method of Preparing Coal Samples for Analysis, and, in 1963, D 2234, Standard Method for Collection of a Gross Sample of Coal. In response to the ongoing needs of the industry, D05 continued to develop reliable means of quickly but efficiently sampling large quantities of coal being shipped by rail, barge, and ship. D05 has developed standards for on-line analysis for the rapid determination of coal characteristics. D05 has also developed standards for in-situ determination of coal stockpile density by nuclear methods and volume by photogrammetric methods. Together, these two standards allow industry to manage coal inventories in a more economic and efficient manner.

From the 1970s to the present, the U.S. coal industry has experienced a significant geographical shift in production, from the Appalachian and Illinois Basin to the Powder River Basin of Wyoming where coal seams up to 100-feet thick [30 m] dominate the countryside. Not only is production from these thick reserves unusually economical, but also the low sulfur coal mined there meets the clean air act requirements without the use of intensive coal cleaning technology that can be necessary to produce compliant fuel from some eastern steam coal reserves.

As the industry migrated westward, D05 had a duty to assure the users of its standards that test methods, written for coals produced predominantly from the Appalachian Basin, are equally applicable for testing lower-rank coals. Where necessary, D05 modified test methods, conducted ruggedness testing and interlaboratory studies that included western coals, and cautioned users of methods how to avoid degradation of these coals while using the standards. However, Powder River Basin coals bring their own set of utilization concerns. These coals can be high in soluble sodium, a major contributor to fouling, which is a condition that can affect heat rates for boilers. Committee D05 has worked with the coal and utility industries in developing sampling and test methods that have been useful in determining heat rates, utilization characteristics, fouling and slagging indices, blending ratios, and other information pertinent to determining the applicability of a particular coal's use in a particular boiler.

In order to handle and process the large volumes and variety of coals, it is necessary to develop rapid and reliable methods for screening coals for end use. It is no surprise that test methods, by far, comprise the largest volume of

Figure 2: Total electric power generation by major sources, 1949-2002[2]



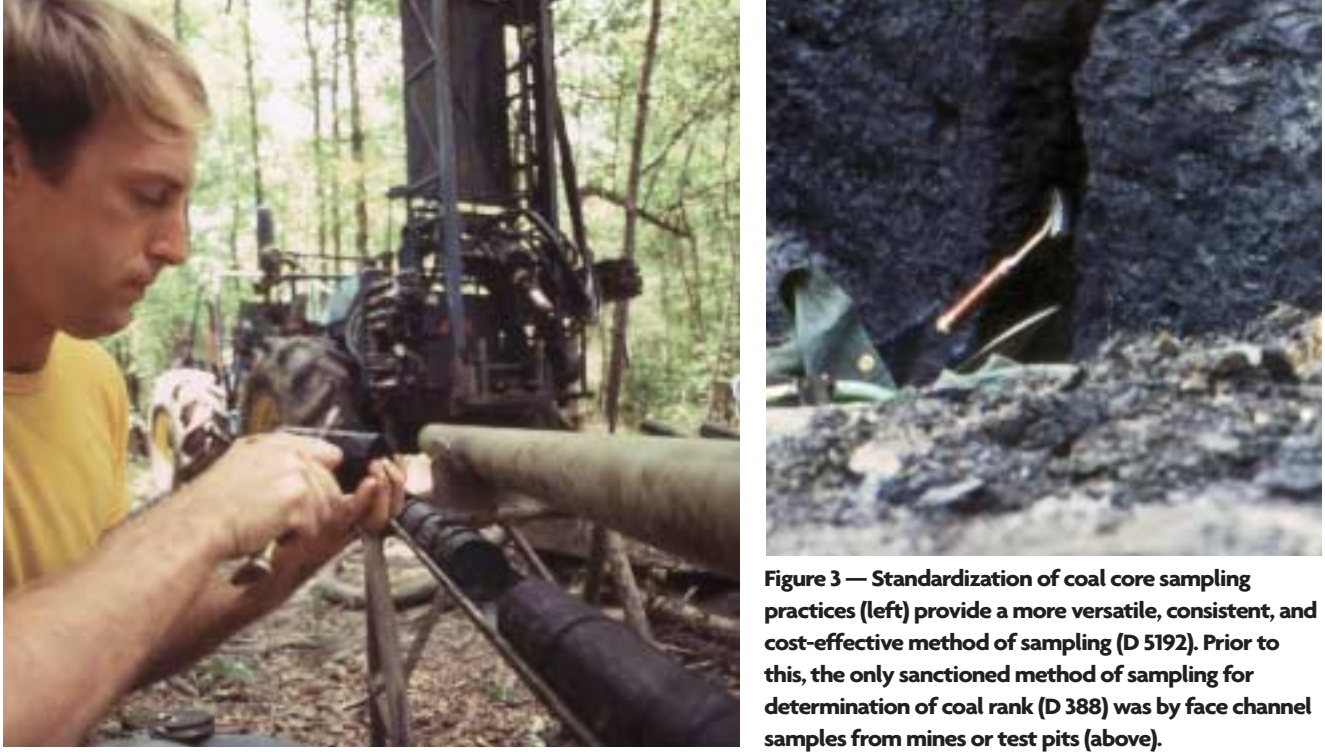


Figure 3 — Standardization of coal core sampling practices (left) provide a more versatile, consistent, and cost-effective method of sampling (D 5192). Prior to this, the only sanctioned method of sampling for determination of coal rank (D 388) was by face channel samples from mines or test pits (above).

D05 standards. In the late 1970s and into the '80s, D05 capitalized on the availability of new instrumentation with computerized operation and data-handling capabilities to address the need for greater productivity and bring about revolutionary alternatives for the classical standards that have served the coal industry for so many years. The first completely automated and computerized method was D 4239, Test Method for Sulfur by High Temperature Combustion. The committee extended this initiative through the 1980s and '90s and into the present with the development of more automated standards for proximate analysis (D 5142, Test Methods for Proximate Analysis of the Analysis Sample of Coal and Coke by Instrumental Procedures), ultimate analysis (D 5373, Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Laboratory Samples of Coal and Coke), and calorific value (D 5865, Test Method for Gross Calorific Value of Coal and Coke).

Through the 1980s and '90s, Committee D05 also introduced coal and coke microscopy standards as practical and reliable tools for determining beneficial metallurgical properties. The initiatives will undoubtedly smooth the transition to direct reduced iron production and pulverized coal injection, newer technologies that are supplanting the use of coke and putting a new face on iron production in the United States.

CLEANER AND MORE EFFICIENT

With the passing of U.S. Public Law 104-113, the National Technology Transfer and Advancement Act of 1995, which requires federal agencies to use U.S. private-sector standards development system whenever possible, D05 has taken a proactive role in the development of standards to measure and monitor elements and compounds of environmental concern in coal. Two new mercury standards, ASTM D 6414, Test Method for Total Mercury in Coal and Coal Combustion Residues by Acid Extraction or Wet Oxidation/Cold Vapor Atomic Absorption, and D 6722, Test Method for Total Mercury in Coal and Coal Combustion Residues by Direct Combustion Analysis, as well as a new chlorine standard, ASTM D 6721, Test Method for Determination of Chlorine in Coal by Oxidative Hydrolysis Microcoulometry, progressed from inception to full standards in less than two years. This not only speaks well of the depth of the technical expertise and the dedication of committee D05 and its members, but also of the procedural and technological advancements introduced by ASTM that have resulted in significant improvements in the process used for advancing credible and industrially-relevant standards without sacrificing the open and democratic due process system that is the hallmark of ASTM International.

The coal industry has seen a dramatic increase in efficiency over the last 100 years. The number of coal mines has steadily decreased from peaks in the 1920s when 11,700 mines employed 700,000 miners. By 2000, there were only about 71,500 miners working in about 1,450 mines. While the number of mines and of miners has decreased, the productivity of America's mines has never been higher. The average production has increased from 0.1 tons [0.46 Mg] per man-hour in 1920 to 7.02 tons [6.37 Mg] by the year 2000. The effectiveness of the industry-driven voluntary consensus standards system promoted by ASTM has paralleled these trends in domestic coal production. Continuous development of new standards and improvements to existing standards has been a fundamental driving force within Committee D05. Standards such as D 5192, Practice for Collection of Coal Samples from Core; D 2961, Test Method for Single-Stage Total Moisture Less than 15% in Coal Reduced to 2.36-mm (No. 8 Sieve) Topsize; D 6414, Test Method for Total Mercury in Coal and Coal Combustion Residues by Acid Extraction or Wet Oxidation/Cold Vapor Atomic Absorption; D 6722, Test Method for Total Mercury in Coal and Coal Combustion Residues by Direct Combustion Analysis; as well as the consolidation and improvements of the calorimeter methods into one standard, D 5865, Test

Method for Gross Calorific Value of Coal and Coke, have all been undertaken in response to coal industry needs. ASTM D05 standards have contributed to the advancement of a more environmentally conscious, efficient and cost-effective coal industry.

AN INTERNATIONAL COMMITTEE

A key contributor to the openness of the ASTM process is that membership in the task groups that formulate the standards is not limited to only ASTM members. An indication of the commitment of D05 to promote an open and free market for world coal trade over the last 10 years is reflected by task groups that have included participation from Australia, Canada, China, Germany, South Africa, and the United Kingdom.

Committee D05 laid the groundwork for international contributions to and participation in the development of ASTM standards by actively participating in the deliberations of International Organization for Standardization (ISO) Technical Committee 27 on Solid Fuels since the 1950s. In the early years, D05 benefited from participation in TC 27 through the exchange of information and by taking part in studies involving such countries as the United Kingdom, where coal maintained a position of industrial prominence. As coal came to play a less important role in the U.K., countries such as Australia and South Africa came to the table and contributed to significant improvements to ASTM standards such as D 409, Test Method for Grindability of Coal by the Hardgrove-Machine Method. More recently, nations such as China, India, Korea and Russia, which are moving to establish viable economies that rely on coal as an economic building block, have benefited from the significant technical contributions advanced by Committee D05 over the past 100 years.

VISION FOR THE NEXT 100 YEARS

If predicted looming natural gas shortfalls materialize, the demand for coal may accelerate as evidenced by a recently announced conference, "Prepare for the Resurgence of Coal-Fired Generation." Globally, coal production, coal-production capacity, and coal use have increased significantly over the past few decades. With all of these increases, global warming and other environmental issues have become a concern of many groups and individuals and many developing nations want assurance that they will have the opportunity to participate in the higher level of living that they see resulting from increased industrialization.

Certainly one of the big challenges for the coal industry is reduction of its environmental footprint. To that end, U.S. President George W. Bush announced in early 2003 that the United States would sponsor a $1 billion, 10-year demonstration project to create the world's first coal-based, zero-emissions electricity and hydrogen power plant. As new technologies for mitigating the environmental effects of coal utilization emerge, there will undoubtedly be requirements for additional coal standards development.

Collaborative efforts with industry, research agencies, the government, and other coal trading nations have made the first 100 years of D05's existence rewarding. The committee is proud of its accomplishments. We are convinced that the challenges of the next 100 years — not the least of which will be to find ways of utilizing coal to meet energy and material demands in a way that sustains and revitalizes the quality of life and the environment — will be met by those who are attracted to an organization with such a commendable heritage.

In October 2004, Committee D05 on Coal and Coke will celebrate its 100th anniversary at ASTM International Headquarters in West Conshohocken, Pa. In keeping with the committee's tradition, the celebration and meeting are open to all. Contact ASTM Staff Manager Scott Orthey (phone: 610/832-9730; sorthey@astm.org).

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Mining a Committee's History

In their lead article on page 22 about the history of ASTM Committee DOS's service to the coal and coke industry, Lou Janke, Jim Luppens, and Ron Graham report on an "informal" survey that asked "What is the power behind the light switch?" Many respondents, when told the U.S. electric utility industry depends heavily on coal, responded, "We still burn coal in this country?"

I'm embarrassed to say, had the authors included me in their survey, I would have been one of those ignorant of the crucial role played today by coal in providing electricity to not only the United States, but many countries around the world. It may surprise you, as it did me, to learn that U.S. coal use actually went up in a recent 26-year span — 51 percent of U.S. electricity was generated by coal in 2002, compared to 46 percent in 1976.

Coal may be thought of as an obsolete or perhaps even depleted resource, sitting at the back of some people's minds along with whale oil, but it is far from either of those. Remember the nine coal miners trapped, then heroically rescued, two years ago at Pennsylvania's QueCreek coal mine? Make no mistake, people are still out there, day and night, mining much of our electricity for us. And right under our noses, in ASTM Committee DOS on Coal and Coke, hundreds of ASTM members have been working over the last century to standardize coal, and its residue coke, so that it can be most efficiently and cleanly used.

Another surprising fact in this month's lead feature is that the United States is the "Saudi Arabia" of coal, with one quarter of the world's accessible and minable coal reserves buried deep in its soil. Still, the work of Committee DOS is international in its scope. The committee first began working to promote free and open global coal trade in the 1950s, when it established a presence on International Organization for Standardization (ISO) Technical Committee 27 on Solid Fuels. To this day, DOS itself enjoys the participation of task group and committee members from Australia, Canada, China, Germany, South Africa, and the United Kingdom.

Even though the number of U.S. mines in operation has dropped dramatically in the last century, from over 11,000 in the 1920s to under 1,500 today, coal production has never been more efficient and more vital. It would not be a stretch to say that this increasing efficiency has been both a cause and effect of Committee DOS's own productivity in developing consensus standards for the industry. One of the main "powers behind the light switch" is not only coal itself, but the ASTM committee that standardizes it.

Letters to the editor can be e-mailed to mgorman@astm.org or can be sent to Standardization News, ASTM International, WO Barr Harbor Dr., POBoxC700, West Conshohocken, PA 19428. Letters may be edited for clarity or space limitations.

Maryann Gorman
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