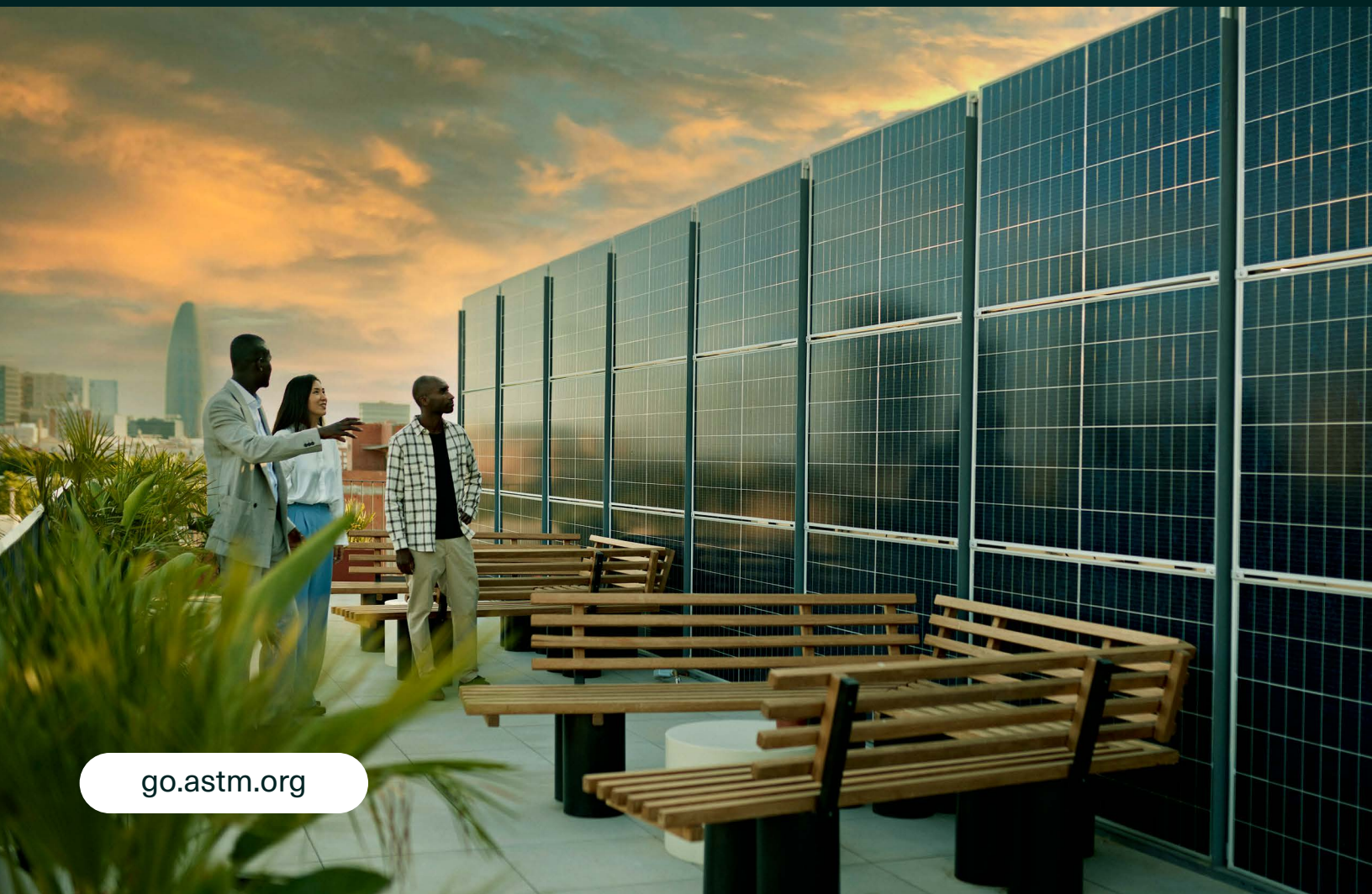




ADVANCING STANDARDS
TRANSFORMING MARKETS

ASTM Energy Standards: Helping to Power Our Lives

Helping Our World Work Better®



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ASTM Energy Standards: Helping to Power Our Lives

As the world confronts the challenges of economic growth and environmental safety, energy will play a central role in the future of these closely related issues. Growing demands for energy are converging with shrinking natural resources and rising concerns over the consequences of climate change.

Spurred on by these challenges, research and innovation are bringing forward cleaner, safer forms of energy to fuel automobiles and airplanes, heat our homes and offices, and provide power for our daily lives. Whether it's aviation fuel, biodiesel, natural gas, nuclear and solar technology, renewable energy sources or much more, the work of ASTM technical committees has an enduring and measurable impact in this field. ASTM International standards make a valuable contribution to the development, production and distribution of energy worldwide.



Since 1904, ASTM Committee D02 on Petroleum Products, Liquid Fuels and Lubricants has developed standards that have helped provide fuels for automobiles and airplanes, lubricants for machinery and heat for homes. Virtually any product that requires fuel or operates on moving parts depends on the more than 800 international standards developed by Committee D02. Today, D02 is ASTM's largest technical committee with more than 2,300 members who represent 71 countries.

LEADERSHIP IN AVIATION AND AUTOMOBILE FUELS

One of the most important contributions that D02 has made is in the area of aviation fuels. D02 standards for jet and aviation fuels help define specific types of aviation gasoline and turbine fuels for civil applications. A critical use of these standards is in describing the quality of aviation turbine fuels from the refinery to the aircraft.

D7566 for aviation turbine fuel containing synthesized hydrocarbons and D1655 for aviation turbine fuels contribute to the production of fuels that are clean and contaminant free, ultimately leading to the safe and economical operation of aircraft.

Similarly, Committee D02 has been instrumental in providing specifications that provide for cleaner gasoline and better automobile performance. D02 standards such as D2699 for research octane number of spark-ignition engine fuel assure consumers of the indicated octane numbers — a familiar gasoline quality that links to product performance — when filling their cars with gas. Legislators, along with engine manufacturers, petroleum refiners and marketers, use octane numbers as a primary measurement to match fuels with engines.

ADVANCING ALTERNATIVE FUELS

ASTM Committee D02 has a proud legacy in developing standards that address alternative fuels such as ethanol and biodiesel. Ethanol is widely used in the United States as a gasoline extender and octane enhancer; it also helps to reduce harmful emissions. Committee D02 has contributed a large portfolio of standards that assist in the production of ethanol:



for fuel ethanol for automotive spark-ignition engines is used in the production of E85 (85% ethanol) motor fuel for flexible fuel ground vehicles.

ASTM International technical committees highlighted in this piece include:

<p>C26 Nuclear Fuel Cycle</p>	<p>D02 Petroleum Products, Liquid Fuels and Lubricants</p>	<p>D03 Gaseous Fuels</p>
<p>D05 Coal and Coke</p>	<p>D18 Soil and Rock</p>	<p>D34 Waste Management</p>
<p>E10 Nuclear Technology and Applications</p>	<p>E44 Solar, Geothermal and Other Alternative Energy Sources</p>	<p>E48 Biotechnology</p>

D02 Proficiency Testing Programs (PTP)

3,400 participating laboratories worldwide

50 classes on petroleum products, coal chemistry, environment and other topics are scheduled annually, and a series of online programs is geared toward petroleum laboratory technicians.

D4806

for denatured fuel ethanol for blending with gasoline is the specification for the ethanol intended to be blended with gasoline to produce E10 (10% ethanol). D4806 is used in close conjunction with D4814 for automotive spark-ignition engine fuel — D02’s widely accepted automotive fuels specification.

Committee D02 is also the authoritative source for standards used in the development of biodiesel: an alternative fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats. Biodiesel use helps reduce such air pollutants as particulates, carbon monoxide, hydrocarbons and air toxins. D02’s flagship biodiesel standard is D6751 for biodiesel fuel blend stock, a standard that refers to the pure fuel before blending with diesel fuel.

The value of D6751 was underscored with the passage of the Energy Independence and Security Act, the U.S. law that promotes the use of alternative fuels and higher fuel economy standards, and mandates that all biodiesel used as fuel blend meet D6751 performance requirements. Committee D02 has also released a series of new and revised biodiesel standards, such as:

D7467

for diesel fuel oil, biodiesel blend, which covers finished fuel blends of between 6% and 20% biodiesel for on- and off-road diesel engine use;

D975

for diesel fuel oils is the definitive standard for diesel fuels used today, and it plays an important role in the production of diesel fuels used to power vehicles and equipment such as trucks, buses, tractors and snowplows; and

D396

for fuel oils helps improve the quality of fuels used for home heating and boiler applications.

Committee D02 is also engaged in numerous activities to advance the use of renewable fuels in the aviation industry. Notable developments include a 2014 revision to D7566 that incorporates Synthesized Iso-Paraffinic (SIP) fuel produced from hydro-processed fermented sugars. The revised standard helps to affirm the safe use of SIP, or low carbon aviation fuel, by airlines throughout the world.

Subcommittee D02.J0 on Aviation Fuels is addressing biomass-produced fuels that would help reduce such greenhouse gases as carbon dioxide. Emerging activities are aimed at synthesized hydrocarbon turbine fuels, alternative fuels derived from coal via synthesis processes such as Fischer-Tropsch and paraffinic kerosene blend stocks synthesized from natural gas.

D02: A PROVEN GLOBAL REPUTATION

Committee D02 has earned a worldwide reputation for high quality, market-relevant standards. With its international membership, D02 maintains close alliances and liaison with leading energy consortia and organizations around the globe. Further evidence of D02’s vast global reach can be seen in its Proficiency Testing Programs (PTP) and training courses. PTP is a statistical quality assurance program that enables laboratories to assess their performance in conducting test methods through comparing their data against that of other participating laboratories. Of the more than 3,400 laboratories that participate in the program, more than 58 percent are from outside the United States. Related training courses are high quality continuing technical education programs for industry and government. More than 50 different classes on petroleum products, coal chemistry, environment and other topics are scheduled annually, and a series of online programs is geared toward petroleum laboratory technicians.



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D03

Supporting Advances
in Natural Gas

Another important source of energy that helps meet day-to-day needs and activities is natural gas. A vital component of the world's supply of energy, natural gas is one of the cleanest, safest and most useful of all energy sources. Serving the standardization needs of the natural gas industry is the focus of ASTM Committee D03 on Gaseous Fuels. Committee D03 develops standards for natural gas, reformulated natural gas, hydrogen, fuel cell gases and other miscellaneous gaseous fuels.

One of Committee D03's standards has paved the way for more efficient hydrogen use. D7265 for hydrogen thermophysical property tables provides a valuable reference for engineers designing equipment for hydrogen generation, transport, storage and delivery to vehicles and appliances.

Alternative energy is also an important part of Committee D03's standards development initiatives. Notable activities include those of Subcommittee D03.14 on Hydrogen and Fuel Cells, which is working on numerous standards relating to the use of hydrogen in energy generation or as feed gas to low, medium and high temperature fuel cells and other gaseous fuels. Hydrogen is a clean energy source that offers great potential as an environmentally friendly solution to power automobiles, heat buildings and much more. Engines that burn pure hydrogen produce almost no pollution, eliminating carbon dioxide emissions and their impact on climate change. Fuel cells are the technology that converts hydrogen into usable energy for a variety of transportation and building-related applications. Often compared to batteries, fuel cells combine hydrogen and oxygen to produce electricity.

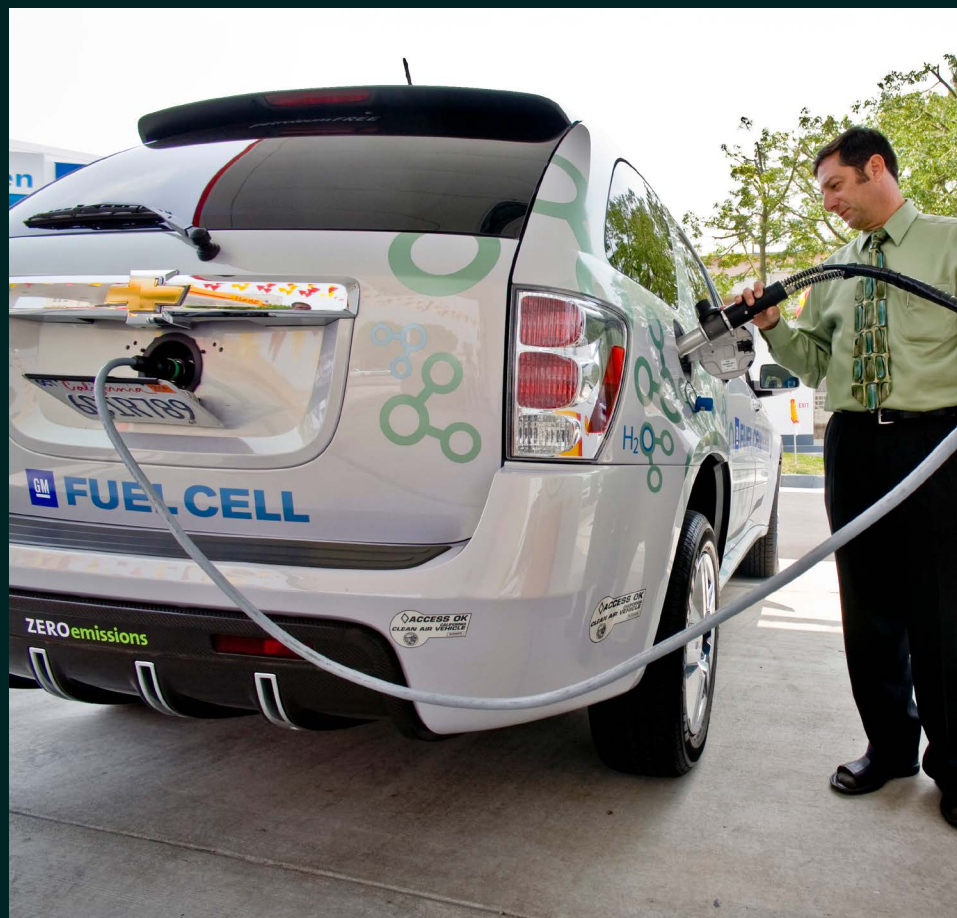
D03.14 has developed ten standards to assist in gas sampling, analysis and composition; thermophysical properties; on line/at line testing; and other critical areas related to hydrogen and fuel cells:

D7550

for determination of ammonium, alkali and alkaline earth metals in hydrogen details a procedure to determine cations in fuel cell feed gases, which are necessary to ensure a feed gas is of sufficient purity for fuel cell systems.

D7941

for hydrogen purity analysis, a test method for the measurement of contaminants in fuel-cell-grade hydrogen.



Promoting Safer Natural Gas Production

With heightened global interest in the advancement of new energy sources, hydraulic fracturing holds great promise in driving continued growth in clean energy development, particularly natural gas. The oil and gas industry is increasingly turning to hydraulic fracturing technologies to tap into vast reserves of oil, natural gas and even geothermal energy located in the shale formations thousands of feet below the earth's surface. Hydraulic fracturing maximizes the extraction of these previously inaccessible resources.

A new ASTM International subcommittee was recently formed to further best practices in hydraulic fracturing throughout the oil and gas industry. Subcommittee D18.26 on Hydraulic Fracturing, part of ASTM Committee D18 on Soil and Rock, is pursuing a standards agenda that will better guide operations in the field and protect downstream air, land and water resources. D18.26 has several new standards currently under development that address critical aspects of hydraulic fracturing operations, including groundwater monitoring, engineering and drilling techniques, and data management and reporting.



D05

and the future of coal

According to the World Coal Association, coal provides 30 percent of global primary energy needs and generates 41 percent of the world's electricity. In addition, 70 percent of steel production worldwide comes from iron made in blast furnaces that use coal. The role of coal in power generation and metallurgical applications is well-entrenched and set to continue into the future.

Helping to plan for the future of this energy is ASTM Committee D05 on Coal and Coke. Founded in 1904, Committee D05 has worked closely with the coal, utility and steel industries to provide more than 70 standards for classifying, sampling and analyzing coal. In recent years, Committee D05 has stepped up its efforts to develop standards that acknowledge the environmental aspects critical to the long-term utilization of coal and promote new coal technologies. Notable standards include D5373 for determination of carbon, hydrogen and nitrogen in coal. Newly revised in 2014, D5373 provides methods to determine carbon in coal, which is essential to the reliable accounting of carbon dioxide emissions.

41%
of the world's electricity
is provided by coal.



ASTM International Committee E44 on Solar, Geothermal and Other Alternative Energy Sources develops standards focused on the conversion of solar and geothermal renewable energy to directly usable energy forms. E44's portfolio of some 50 standards addresses such areas as the heating of domestic hot water; active and passive space heating and cooling; process heating; thermal conversion power generation; photovoltaic generation of electricity and advanced energy conversion, including wind energy.

A major thrust of E44 activities is solar energy technologies that take advantage of the sun's energy and light to provide heat, light, hot water and electricity for homes and businesses. A primary example is photovoltaic (solar cell) systems that convert sunlight directly into electricity — commonly referred to as the photovoltaic effect. Photovoltaic arrays — an interconnected assembly of solar panels — can be used on rooftops to supplement power use for homes and office buildings.

Committee E44 has been actively engaged in the advancement of PV technology through the efforts of Subcommittee E44.09 on Photovoltaic Electric Power Conversion. E44.09 offers more than 20 test methods focused on qualifying the performance of photovoltaic systems in various conditions. Many of these ASTM test methods form the foundation of qualification standards developed by other national and international standards developers such as the Institute of Electrical and Electronics Engineers and the International Electrotechnical Commission.

- E2527 for performance of photovoltaic systems under natural sunlight offers a recognized procedure for testing and reporting the electrical performance of a photovoltaic concentrator module or system.
- Similarly, E1171 for photovoltaic modules in cyclic temperature and humidity environments provides industry stakeholders with useful guidelines to assess module performance in varying conditions.



Photovoltaic arrays — an interconnected assembly of solar panels — can be used on rooftops to supplement power use for homes and office buildings.

ASTM Committees Contribute to Safe Nuclear Energy

Helping to advance the growth of safe nuclear power and technology is the focus of the standards activities of several ASTM committees. One such committee is C26 on Nuclear Fuel Cycle. With a membership of more than 160 professionals and a portfolio of approximately 170 standards, Committee C26, which maintains a close relationship with the U.S. Nuclear Regulatory Commission, plays a critical role in all aspects important to the nuclear fuel cycle, including spent nuclear fuel, waste materials and repository waste packaging and storage. Committee C26 standards facilitate commerce, worker safety, public and environmental health, and regulatory compliance within the nuclear fuel cycle. On the commercialization side, C26 standards make an important contribution to the development of nuclear fuel cycle products. Notable standards in C26's portfolio include:

- D996** for uranium hexafluoride, which provides the nuclear industry with a standard for enriched uranium used in fuel fabrication.
- D1751** for sampling radioactive tank waste addresses techniques used to obtain grab samples from tanks containing high level radioactive waste created during the reprocessing of spent nuclear fuels. Because of the high level of radiation exposure, access is limited to these tanks. C1751 provides guidance on techniques and the appropriate devices to obtain these samples.
- C1672** for determination of uranium or plutonium isotopic composition was developed in response to requests from fuel producers around the world. This test method is

used for waste handling and disposition, establishing inventory values as part of a safeguard system, environmental analysis, nuclear forensics and bioassay applications.

The standards developed by Committee E10 on Nuclear Technology and Applications promote the advancement of nuclear science and technology and the safe application of nuclear energy in all forms. These standards cover many topics important to the nuclear industry, including radiation dosimetry, structural materials and the decontamination, decommissioning and extended life operation of nuclear facilities. E10 standards also play an important role in protecting the public from potential nuclear-related hazards as well as facilitating the health and safety of nuclear facility workers.

E1168 for radiological protection training for nuclear facility workers defines the elements of a health and safety training program for the radiological protection of workers at nuclear facilities.

E2956 for monitoring the neutron exposure of light water reactor pressure vessels establishes the means and frequency of monitoring the neutron exposure of pressure vessel throughout the reactor's operating life. This standard was created to address

a U.S. Nuclear Regulatory Commission requirement of light water reactor surveillance of materials.

Helping Define the Next Generation of Nuclear Facilities

Newer initiatives within Committee E10 are aimed at developing standards for new and improved nuclear plant systems and designs. A group of countries, including the United States, has agreed on a framework for cooperation in research about a new generation of safer, reliable and sustainable nuclear systems called Generation IV. Committee E10 is evaluating standards needs for addressing near-term issues related to Generation IV reactors.

ASTM Nuclear Portal: Comprehensive Knowledge Bank for Industry Stakeholders

To provide stakeholders with a single source for technical standards across the nuclear energy field, ASTM International launched a nuclear portal in 2012. The portal (www.astm.org/portals/nuclear) brings together the latest information on newly published ASTM standards; proposed new standards and revisions to current standards; nuclear-related ASTM standards-developing subcommittees and committees, including C26, E10 and others; schedules of upcoming meetings and symposia; and video presentations from nuclear industry officials.



With many new system installers now entering the market, there is a growing need for best practice installation guidelines for both residential and commercial applications. In 2013, E44.09 responded with the release of E2766 for installation of roof mounted photovoltaic arrays. E2766 addresses requirements such as proper water-shedding integration with the existing roof system, water sealing of roof penetrations and sufficient anchoring per regional pressure load requirements. Also included are safety and hazard considerations such as worker fall protection on high pitched roofs, electrical exposure, accessibility of modules and roof clearance around the perimeter of the array.

An important new activity currently underway in E44.09 is the development of a practice detailing the minimum requirements for the installation, commissioning, operations and maintenance process during the expected life of a photovoltaic power plant. The activity was born from the needs of industry stakeholders, specifically investors

and insurers, for a standard that would support large-scale commercial photovoltaic installations and help ensure safe and reliable power generation.

QUALITY AND SAFETY IN SOLAR SYSTEMS

Complementing the activities of E44.09 are those of Subcommittee E44.05 on Solar Heating and Cooling Systems and Materials. E44.05 has developed a wide range of practices for safe and reliable design, installation and operation of solar heating and cooling systems. These standards are used by designers, manufacturers, distributors, installers, contractors, regulatory officials and building owners. For example, E424 for solar energy transmittance and reflectance assists building designers in selecting and specifying glazing materials for solar energy transmittance. Other notable E44.05 standards include the following:

E683 for installation and service of solar space heating systems provides installation and service practices for solar

heating systems to help ensure adequate performance, safety and customer satisfaction.

E1056 for installation and service of solar domestic water heating systems delineates operation and service guidelines for solar domestic water heating systems.

COOPERATION WITH SOLAR ABCS

Committee E44 is taking aim at numerous other industry standardization needs that will further propel the commercialization and adoption of solar energy technologies. To achieve these goals, E44 technical experts are working closely with the Solar America Board for Codes and Standards (Solar ABCs), one of the major projects of the U.S. Department of Energy's Solar America Initiative market transformation efforts.

TAPPING THE POWER OF THE EARTH'S CORE

Geothermal energy — the thermal energy contained in the rocks and fluids of the earth — offers great potential as an abundant

source of renewable power. This energy can be found in shallow ground and in the hot water and hot rock located a few miles beneath the earth's surface. Geothermal energy is clean, sustainable and available 24 hours a day. Tapping into this resource to heat and cool buildings requires geothermal systems, which include a heat pump, an air delivery system and a heat exchanger, which is a system of pipes buried in the shallow ground near the building.

The science and application of geothermal energy is the focus of the standards development efforts of Subcommittee E44.15 on Geothermal Field Development, Utilization and Materials. E44.15 standards improve communications among industry stakeholders by providing consistent terminology and offering practices and test methods for evaluating the quality of geothermal resources, determining material compatibility for geothermal hardware and defining the performance of power conversion technologies.

The most widely accepted E44.15 standard is E1675 for sampling geothermal fluid for chemical analysis. E1675 is utilized in 17 countries to guide the collection of representative samples of the steam and liquid phases as they exist in the pipeline at the sample point. To help further advance geothermal energy technologies, E44.15 has launched the development of a new practice aimed at defining the requirements for the installation, testing, commissioning and maintenance of closed loop geothermal heat exchangers.

In the ever-changing field of energy, ASTM International will continue to remain a constant source of high quality standards that meet the needs of industry stakeholders and consumers around the world.



Empowering Innovation in Biomass Energy

▲ Biomass is another dynamic area of renewable energy that is on the agenda of ASTM International technical committees. This energy source is derived from biological material, particularly wood. Other sources of biomass include plants, agriculture residue (corn, wheat and sugar cane), forest remains (dead trees, branches and tree stumps) and the organic components of municipal and industrial wastes. Biomass can be converted directly into liquid biofuels such as ethanol and biodiesel, which are used in a myriad of transportation applications.

ASTM Subcommittee E48.05 on Biomass Conversion, which is part of Committee E48 on Bioenergy and Industrial Chemicals from Biomass, is addressing standardization requirements in the area of biomass through a wide range of specifications and test methods. The committee has representation from the National Renewable Energy Lab, a subsidiary of the U.S. Department of Energy, along with the U.S. Food and Drug Association. E48.05 standards support research, testing and production of biofuels.

ASTM Committee D34 on Waste Management also continues standards development in the renewable energy field through the efforts of its Subcommittee D34.03 on Treatment, Recovery and Reuse. D34.03 offers an extensive set of standards used in the research and production of refuse-derived fuels (RDF), which consist of organic components of such municipal wastes as plastics and biodegradable waste. Producers and users of RDF benefit from D34 standards such as E953 for fusibility of refuse-derived fuel ash, and E791 for calculating refuse-derived fuel analysis data.



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