SETTING THE STANDARDS: HOW STANDARDS ENHANCE QUALITY AND PROMOTE RELIABILITY

By David Holthaus

Standards in manufacturing are essential to ensuring quality products and to improving the accuracy and reliability of the materials used to make them.

They are also critical to promoting the safety of those who use the products, and sometimes it can literally be a matter of life and death.

In 2018, after two years of work, a committee of ASTM International, one of the world's largest standards-developing organizations, published requirements for bullet-resistant doors on police vehicles.

The standard called for door panels to be made from a combination of ceramic and fabric, with the ceramic material acting as the strike face to break bullets that were made with steel cores. Such ammunition was increasingly being used in the high-powered weaponry that police were encountering on the streets, according to ASTM. Panels made with basic, armored steel often would not stop bullets with steel cores.

The new specification standardized protection levels and included language to help public safety agencies retrofit their vehicles or buy new ones with the safer ceramic-fabric panels.

It was a dramatic example of how standards evolve to keep up with new technology, materials, and processes.

Perhaps not as dramatic, but equally important in terms of safety and reliability, is the development and evolution of standards used to make refractories, the materials used to build structures routinely subjected to high temperatures.

The ASTM International Committee C08 on Refractories was founded in 1914. Over its history, the committee has defined what a refractory is, clas-

ASTM International's headquarters in West Conshohocken, Pa.
Credit: ASTM International

sified them by type and function, and defined tests to determine their suitability for specific applications.

In the early decades of the committee's existence, refractories were used to build the linings of fireplaces, kilns, and stills, among other applications. By the end of the 20th century, refractories were used to line nuclear reactors and in the manufacturing of reentry heat shields for space shuttles.

The new uses demanded standardized tests to benchmark performance and to help evaluate and develop new materials.

Bill Headrick has been involved with creating and refining ASTM standards for more than 30 years, and he is currently working with Committee C08 as the chair of the technical subcommittee on monolithics.

Standards for the production of refractories have evolved since 1914. *Credit: RHI Magnesita*

Headrick is head of research and development for aluminosilicate products for the Americas at RHI Magnesita, the world's largest refractories company.

There are more than 100 standards relating to refractories alone, and the manual on refractory standards is nearly an inch thick, Headrick says. Committee members are engaged in a continuous process of evaluating and reviewing the standards to make sure they are up to date. In August alone, Headrick says the committee reevaluated six standards.

"The biggest thing is making sure we're using the best available methods," he adds.

For example, for years, the only method for determining the chemistry of materials was wet chemistry, and the relevant standards only addressed those methods. "Now, we have X-ray fluorescence, X-ray diffraction, mass spectroscopy, and we've had to rewrite our standards to take into account these better methods that give better results," he says.

The committee is currently doing a lot of work to make standards safer, Headrick says, and to have them align with the health and safety requirements of employers.

Bill Headrick
RHI Magnesita

Some of the standards for measuring chemistry use materials that are considered hazardous to health, leading the committee to look for alternative materials that are safer and can produce similar results.

"That's the biggest evolution going on," he says. "We're going through all the standards and making sure they're as safe as possible."

It is a deliberative process.

Every five years, ASTM standards must be reviewed and reapproved by the appropriate subcommittee and then by the main committee. Any negative comment about the proposed standard must be resolved before the standard can be approved.

"To pass a standard, you have to eliminate every single negative," Headrick says. "Once everyone is in full, 100 percent agreement, then the standard is published. That can take a matter of months to a number of years."

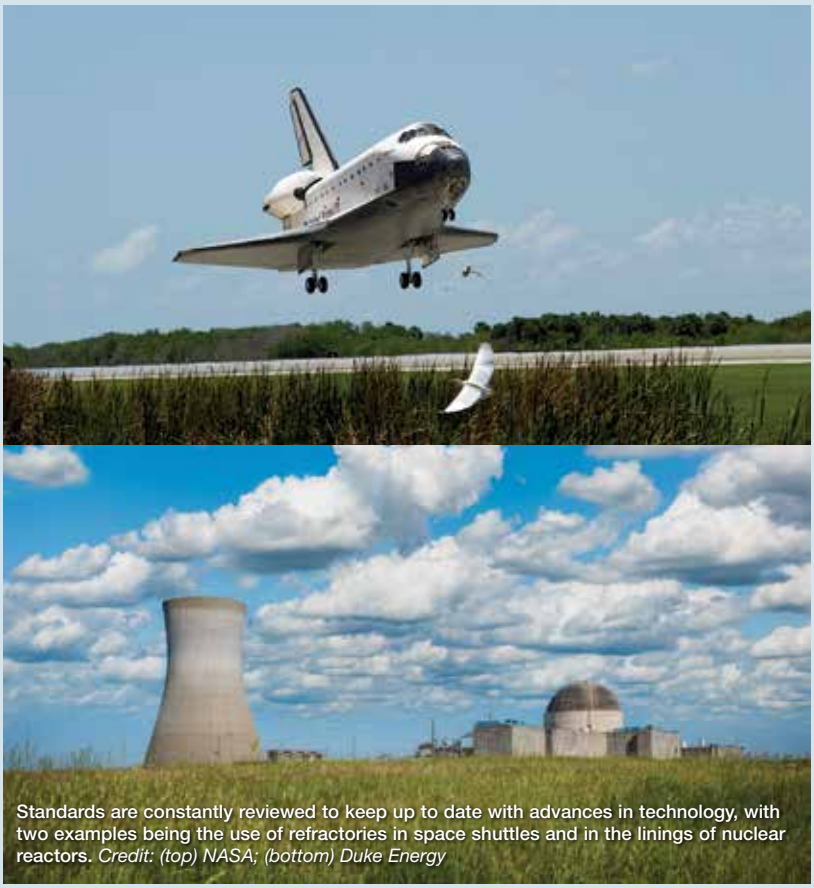
For several years now, ASTM committees and subcommittees have worked on the standardization of the growing and developing field of additive manufacturing, the process of fabricating parts and components layer by layer using computer-aided design rather than traditional manufacturing methods.

Improved technology, advanced equipment and sensors, and more suitable materials are driving the productivity and reliability of additive manufacturing production, yet the rapid change has pointed up the need for standardization, says Mohsen Seifi.

Seifi is ASTM's director of global additive manufacturing programs, responsible for additive manufacturing programs that support standards development and other products and services at the organization. He also oversees its Additive Manufacturing Center of Excellence, which has the mission to bridge the gap between standardization to research and development.

By 2008, the nascent additive manufacturing industry had reached the point where standards were needed.

"Without standards, it's going to be the Wild West," Seifi says. "Industry needs standards for rapid implementation of this technology for critical applications."



Standards are constantly reviewed to keep up to date with advances in technology, with two examples being the use of refractories in space shuttles and in the linings of nuclear reactors. *Credit: (top) NASA; (bottom) Duke Energy*

Additive manufacturing's shortened development cycle and more efficient process means products can be designed and produced more quickly, but standardization is necessary to create consistency and reliability, and to serve as a foundation for continued growth.

"Innovation is inevitable, but without having standards in place, you can't really drive this technology forward in terms of full implementation and adoption to satisfy regulation," Seifi says.

"The reason is very clear," he adds. "You need to make sure we're all communicating the same language and making products in a repeatable and reliable fashion."

Mohsen Seifi,
ASTM International

ASTM's committee on additive manufacturing technologies has met since 2009 and now has more than a thousand members from more than 35 countries who have developed standards that support the application and adoption of additive manufacturing for diverse materials and processes across various industry sectors.

In 2011, ASTM International and the International Organization for Standardization (ISO) signed an agreement paving the way to create joint additive manufacturing standards in order to increase collaboration and minimize duplication of efforts.

"If you are a user of this technology interested in fabricating parts and components, are you going to receive the same results if you produce a part at a service provider in the U.S. versus Europe versus Asia?" Seifi says. "That's where standards play a critical role to make sure we manufacture products in a consistent, reliable, and repeatable manner."

Another key reason for standards is to facilitate certification of additively manufactured parts from regulatory bodies such as the Federal Aviation Administration, NASA, Department of Defense, Food and Drug Administration, and many others.

"Once a standard is out, it has the potential to become part of regulatory frameworks and can get into federal codes and referred to in federal contracts," Seifi says.

One of the key trends on additive manufacturing standardization is understanding the challenges the technology brings in regard to data management and schema, Seifi says. The 3D printers and their sensors can generate gigabytes, sometimes terabytes, of data. "The question is, what data to collect according to what standard and format and why?" he says. "Is that data you collect findable, accessible, and reusable? Does it make sense to capture that data, and using what standard method? What kind of intelligence can we generate from the data to improve the process?"

"There are major standard gaps in this space that ASTM is trying to fill," he adds.

In the cases of newer technologies such as additive manufacturing, and older processes such as refractory production, standards have helped advance processes, improve quality, and enable those production methods to be used reliably in a growing range of industries and applications.

A short list of standards-developing organizations

There are many organizations in the U.S. and around the world that work to develop standards for their industries. Here are some that apply to manufacturing:

- **The Association for Manufacturing Technology**
  Based in McLean, Va., the association promotes the interests of American manufacturing machinery and equipment, including the standardization of technology used to run machines. www.amtonline.org

- **The American Nuclear Society**
  Based in LaGrange Park, Ill., the Society advances the development of nuclear science, engineering, and technology, and maintains a standards committee and board. www.ans.org

- **The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)**
  Based in Atlanta, Ga., the Society focuses on building systems, energy efficiency, indoor air quality, refrigeration, and sustainability through research, standards writing, publishing, and continuing education. www.ashrae.org

- **American Society of Mechanical Engineers**
  Based in New York City, N.Y., the Society enables collaboration and skills development across engineering disciplines through programs in continuing education, training and professional development, codes and standards, research, and conferences and publications. www.asme.org

- **ASTM International**
  Formerly known as American Society for Testing and Materials, ASTM International is an international standards organization that develops and publishes consensus technical standards for a range of materials, products, systems, and services. It is headquartered in West Conshohocken, Pa., outside of Philadelphia. www.astm.org

- **International Code Council**
  Based in Washington, D.C., the Council is an association of building safety professionals and a source of model codes and standards that establish baselines for building safety. www.iccsage.org

- **The International Organization for Standardization (ISO)**
  Headquartered in Geneva, Switzerland, ISO is an international standard-setting body composed of representatives from various national standards organizations. It promotes worldwide proprietary, industrial, and commercial standards. www.iso.org

- **The International Committee for Information Technology Standards (INCITS)**
  Based in Washington, D.C., this committee is a standards development organization composed of information technology developers. www.incits.org

- **The International Society of Automation**
  Based in Research Triangle Park, N.C., the Society is a technical society for engineers, technicians, businesspeople, educators, and students, and it sets standards for industry professionals in automation. www.isa.org

- **National Institute of Standards and Technology (NIST)**
  Headquartered in Gaithersburg, Md., NIST is a nonregulatory federal agency within the U.S. Department of Commerce that develops and disseminates standards that allow technology to work seamlessly and business to operate smoothly. www.nist.gov

- **NSF International**
  Based in Ann Arbor, Mich., NSF International has developed more than 80 public health and safety standards, and tests and certifies products to verify they meet those standards. www.nsf.org

- **SAE International**
  Previously known as the Society of Automotive Engineers, Warrendale, Pa.-based SAE International is a standards-developing organization for engineering professionals in various industries. Its principal emphasis is on global transport industries, such as aerospace, automotive, and commercial vehicles. www.sae.org

- **UL**
  Formerly known as Underwriters Laboratories, UL is a global safety certification company headquartered in Northbrook, Ill. It is approved to perform product safety testing by the U.S Occupational Safety and Health Administration. www.ul.com