

# ELECTRON ENERGY CORPORATION

Electron Energy Corporation (EEC) is an international leader in the production of rare earth magnets and magnet assemblies. Privately owned, it was founded in 1970. The company began with just two employees working in an old milk house on a dairy farm near Manheim, Pennsylvania. From those humble beginnings, EEC progressed steadily to a position of prominence in high performance magnets of the type that are vital to various high-technology industries, including those of communications, defense, and medicine.

EEC's founder was Marlin S. Walmer (1929-1999), a pioneer in the science of rare earth magnets and their applications. An engineering graduate of Lehigh University, he subsequently received a Master of Science degree in physics from Franklin and Marshall College and, following two years of service in the U.S. Navy, began his professional career as a metallurgical engineer at the Hamilton Watch Company. While at Hamilton, Walmer developed a process to produce platinum cobalt magnets used in the world's first electric wristwatches. Although these magnets were very powerful, they were also very expensive—too expensive to find broad industrial application. Later, when an alloy system based on the rare earth element samarium and the transition metal element cobalt was discovered, which appeared to have potential for superior magnetic properties at far less cost, he left his position at Hamilton Watch to pursue the technical and commercial development of this revolutionary magnet material.

Actually, the so-called rare earth elements such as samarium and neodymium are neither rare nor earths. In fact, they are metals that occur in nature as oxides in relative abundance. Nevertheless, the term rare earth continues to be used for this family of metallic elements.

A rare earth permanent magnet is a combination of metals called an alloy—at least one of which is a rare earth—that retains its magnetism after being magnetized. Alloys based on rare earth elements are the latest and most advanced permanent magnets known today.

The first significant application of samarium cobalt magnets occurred in the defense industry in 1970 as part of advanced



technology used by the United States Air Force, and Walmer's fledgling company, EEC, was one of only three companies in the world that could produce them.

Commercial uses for rare earth magnets progressed steadily thereafter. In many industries the introduction of these materials was a revolutionary event as designers—stimulated by the advantages they offered of lighter weight and increased magnetic strength, stability, and temperature capability—pushed to create new devices and to reach higher levels of performance. Under Walmer's leadership, EEC focused on developing new alloys based on rare earths and on providing engineering and design expertise to enhance their customers' devices. From the outset, his business philosophy was straightforward: Be ethical. Produce high quality products for the most demanding applications. Delight the customer! Although Marlin Walmer died in 1999, he lived to see his forecast for the potential of rare earth magnets come to fruition. Walmer's pursuit of excellence and business philosophy continues at EEC under the leadership of his son, Michael H. Walmer, who is also an accomplished materials science engineer, and the excellent staff he recruited and trained.

The company's current home, a 40,000-square-foot facility in Landisville, Pennsylvania, was built in 1985 and is state-



*Marlin S. Walmer (1929-1999), founder of Electron Energy Corporation, was an engineering graduate of Lehigh University who became familiar with platinum cobalt permanent magnets while working as a metallurgist with Hamilton Watch Company. Marlin believed that powerful magnets would have broad applicability if only a more economical alloy system could be developed. When samarium cobalt alloys were discovered, he left his position at Hamilton to pursue their technical development and, ultimately, commercialization. Marlin was a true pioneer in the field and EEC, the company he founded, became one of the first to sell rare earth magnets. Widely recognized for his contributions to the science and technology of these materials, he lived to see his forecast for their importance come to fruition.*



of-the-art in equipment, expertise and technical personnel. As a fully-integrated producer, EEC designs alloys to meet specific requirements and then manufactures them under precisely controlled conditions, in effect, making each customer's order a custom product. That capability is now unique among U.S. magnet producers, as all others are processing magnets or alloys purchased from foreign sources.

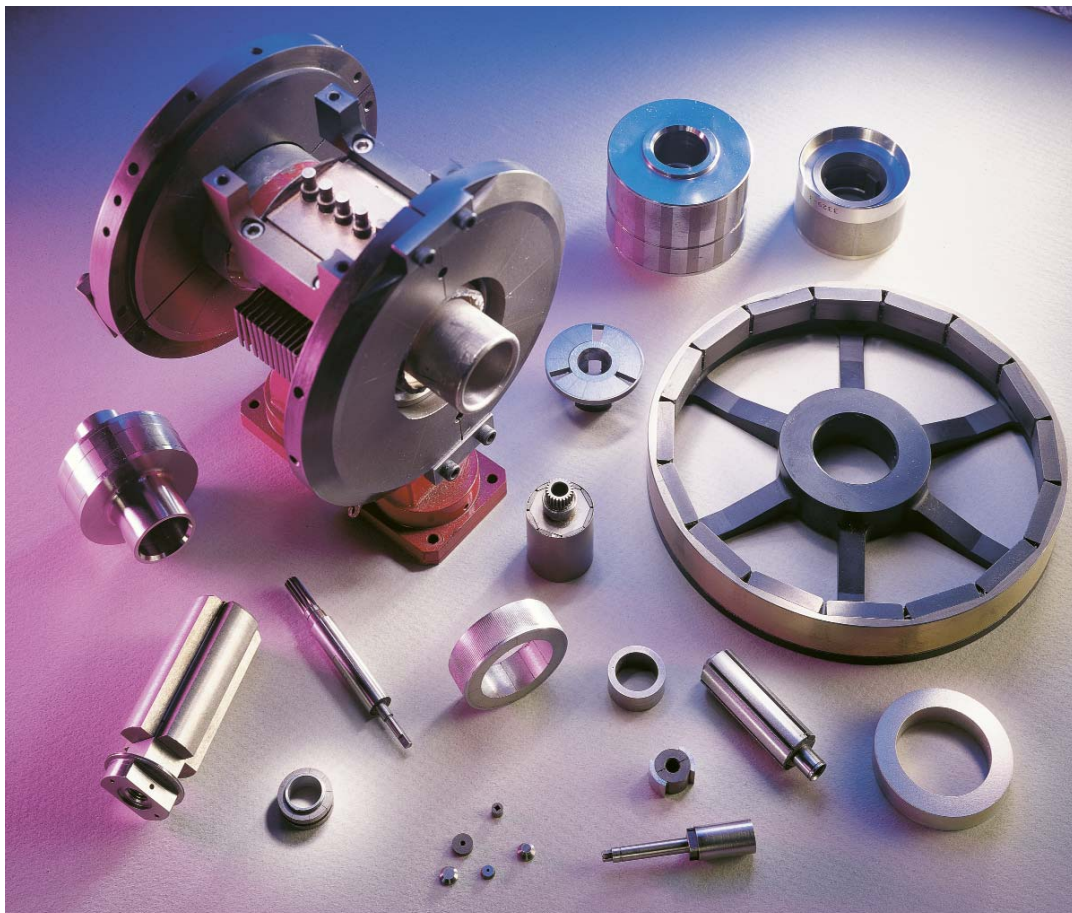
Typically, EEC begins the design process by working closely with the customer to understand the requirements and to contribute know-how to the product's design. In this role

Electron Energy serves as a virtual in-house source of magnet technology and an extension of the customer's own technical capabilities.

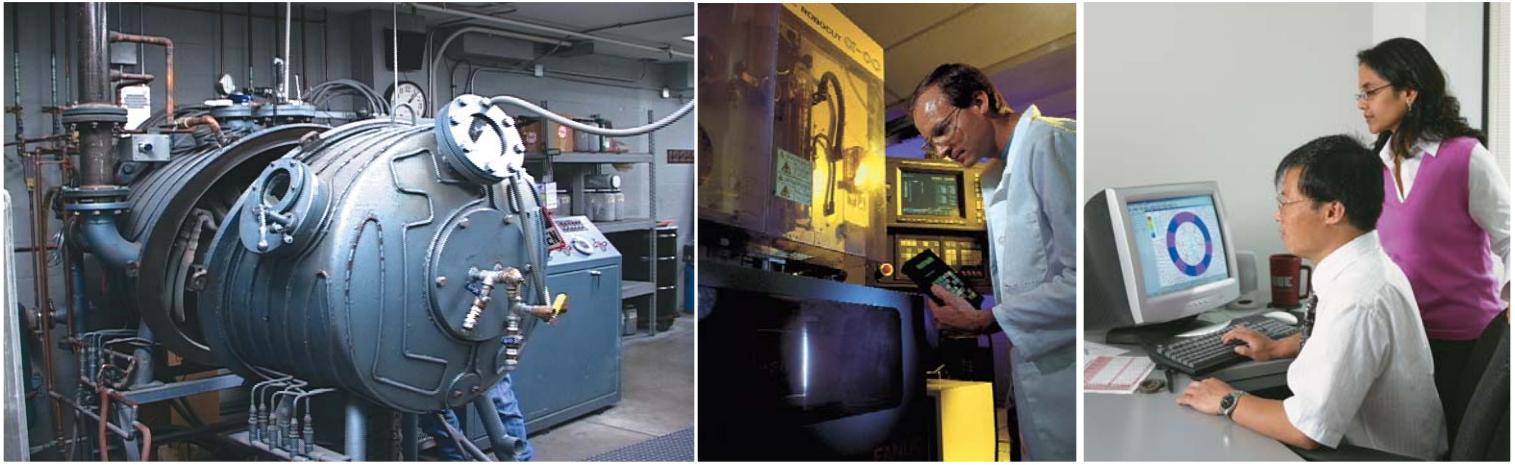
The next step is to produce a magnet alloy that will meet the requirements. Manufacturing starts by combining the constituent elements and melting the alloy in vacuum furnaces. The alloy is then processed through a series of carefully controlled powder metallurgical procedures (pressing and sintering). Because sintered magnets are extremely hard and brittle, they cannot be brought to their final dimensions by conventional machining. Thus grinding, lapping and electrical discharge



*Above: The enterprise that became EEC started in 1970 in a milk house in Lancaster County. From this very modest beginning the company grew steadily and in 1985 moved into a brand new facility of more than 40,000 square feet in Landisville, which is now their home. As a manufacturer of high technology products EEC's plant contains state-of-the-art equipment and a highly trained professional staff. The company is the only vertically-integrated magnet producer remaining in the U.S. In other words, EEC designs and then produces magnet alloys by melting them from constituent elements.*



*Left: Permanent magnets are alloys based on a combination of metallic elements that retain their magnetism after being magnetized. The most powerful magnets are made from the elements samarium and neodymium—rare earths. Actually, the rare earth family of elements is neither earths nor especially rare; rather, they are metals in common abundance. Because these magnet alloys are extremely hard, they require special handling and fabricating techniques. Typically, these magnets are manufactured by pressing and sintering powdered metal or by molding the particles in a polymer or metallic matrix. EEC produces both sintered and bonded magnets as well as magnet assemblies. The company specializes in applications engineering and in component design.*



❖ *Specialized equipment is required in nearly every step of manufacturing high performance magnets. Typically, the alloy compositions are melted in a vacuum furnace, converted to powder and handled under protective atmospheres. Because they are extremely hard and brittle, rare earth magnets are finished by operations like grinding, lapping, and electrical discharge machining (EDM). Establishing and measuring magnetic properties also involves test equipment and procedures often unique to the industry. To design components and assemblies, EEC uses state-of-the-art computer techniques such as two- and three-dimensional finite element analysis.*

cutting finishes them. Magnetizing requires specialized equipment, as do the procedures for testing and adjusting. Although the company's primary products are based on sintered samarium cobalt, they also offer neodymium-iron-boron and bonded magnets.

EEC's in-depth knowledge of magnetic materials and decades of practical experience with magnets and magnet assemblies enable it to provide innovative solutions to challenging customer requirements. Demand for EEC's technical services and application engineering capabilities has grown steadily. An engineering team is available to work closely with customers to determine their needs, participate in product design and ultimately fabricate prototypes. This, too, requires a professional staff and an investment in specialized equipment such as two- and three-dimensional finite element analysis computer-based modeling.

Quality products have been a hallmark of the company since its inception. EEC's quality system is certified to ISO 9001:2000; their traceability system has been approved by the aerospace industry. In support of their needs for magnetic materials characterization and for conducting research and development, EEC operates a state-of-the-art magnetics laboratory. Another distinctive attribute of Electron Energy is its commitment to being a technology leader—constantly pushing the edge of magnet technology. Research, often conducted in conjunction with universities and sponsored by various government agencies, has yielded a stream of new and improved products. Examples of successful research include:

- In response to a U.S. Air Force need for magnets that could maintain their properties at higher temperatures, EEC developed a composition capable of operating at 550 degrees Celsius and was awarded a U.S. patent. This proprietary alloy (SmCoUT™), which significantly increases the maximum service temperature of these powerful magnets, is also available for commercial applications.
- EEC developed a tougher, more crack-resistant version of neodymium-iron-boron (NEO) magnets. Typically, these magnets are quite brittle and EEC's new technology doubled the toughness of the magnet while maintaining very high magnetic properties. These new alloys have been patented and trademarked as "Tough NEO."

Such developments and others that have resulted from EEC's highly successful, on-going research program play a large part in the reputation EEC enjoys.

The international profile of this small company is attested to by the important role its products and services play in many high-technology industries.

EEC is the world leader in supplying ready-to-assemble magnet stacks for traveling wave tubes, or TWTs, which are used to amplify microwave signals in communications and defense systems. Typical applications for these devices are the radars of F-16 and F-18 jets, unmanned aircraft and naval vessels. Modern satellites, both civilian and military, also rely on TWTs to communicate a wide range of functions. Other military applications of EEC magnets include reactor control system

components in nuclear submarines and the gyroscopes and accelerometers used in control systems of air- and ground-based vehicles.

In addition to uses in satellite communication, EEC magnets provide the precision control, stability and reliability that are required of the accelerometers and gyroscopes of the space shuttle. Electron Energy's magnets also played a key role in the innovative propulsion system developed for NASA's Deep Space 1. EEC's high temperature samarium cobalt magnets were on board as Deep Space 1 exited our solar system, giving employees pride in being able to claim their products are "out of this world."

One of the newest and fastest-growing markets for rare earth magnets is medical science and technology. Examples include high-speed motors of hand-held, cordless surgical power tools.

The esteem in which Electron Energy Corporation's products and services are held is reflected in the many awards granted by customers and government agencies. The United States Small Business Administration has consistently recognized the company as Small Business Contractor of the Year in Region III and cited it for outstanding contributions and service to the nation. Customer recognition

includes numerous certificates of excellence and citations for outstanding performance such as "consistently supplying superior products on time and at affordable cost." Following Marlin Walmer's death in 1999, a major producer of traveling wave tubes took the unusual step of presenting a memorial to EEC for "creating a lasting business relationship unparalleled by others." The International Rare Earth Magnets Society bestowed posthumous recognition on Walmer for a "lifetime of achievement" and the Chief Scientist of the U.S. Air Force wrote, "The Air Force and the nation have benefited greatly from his insight and energy. His contributions to our national defense and economy have been immense...we will miss him."

Proud of their heritage and of being an American company based in Pennsylvania, the management and employees view their past accomplishments as a solid base on which to build, and the principles established by the founder as guidelines for doing business, now and in the future. They are committed to maintaining Electron Energy Corporation's position as a world leader in advanced magnetic materials.

For more information about Electron Energy Corporation and its products and services, please visit [www.electronenergy.com](http://www.electronenergy.com).



*Applications for rare earth permanent magnets include almost every field of modern technology. In fact, in many cases, these magnets play a role in "modernizing" the technologies. Aerospace, telecommunications, and military systems are typical of those that use components enhanced by EEC products. One such component is traveling wave tubes, which are used to amplify microwave signals vital for satellite communications and electronic warfare. EEC is a world leader in supplying magnets for these devices.*