There are myriad good reasons to ensure the uninterrupted, optimal performance of magnetic separation units in your food production facility, not the least of which being the legislative requirements set forth by the Food Safety Modernization Act of 2011. But, for decades before the federal government intervened, responsible food manufacturers have recognized the benefits of deploying magnetic separators at critical points in the production line. Long before the FSMA was passed, self-regulation led to the HAACP and BRC standards many have ascribed to. While the mitigation of metal contaminants is just one fundamental of those standards, the industry has accepted that properly-functioning magnetic separation devices are a key component of food safety assurance and business continuity.

As magnetic separation technology for food safety applications has matured, so too have the inspection and testing technologies and protocols that ensure its ongoing functionality. Some 50 years ago, the efficacy of magnetic separation was limited to highly-magnetic ferrous metals, such as mild steel. With the development of the rare earth magnetic devices manufactured for food safety today, the range of metals that modern magnetic separators are capable of removing from production materials has expanded, thus expanding the role of the magnetic separator in the food manufacturing industry. With that expansion comes a new focus on monitoring, managing, and maintaining the magnet per manufacturer specifications. The implications are twofold; demonstrated adherence to the metal contamination elimination effort is good for new business efforts, and it mitigates the grave and costly recall and consumer risk consequences of shipping contaminated finished goods.

In this paper, we’ll discuss the factors that impact magnetic separation unit performance, assess the two standard means of testing magnetic separator performance as part of your greater magnet audit exercise, and offer some best practice advice for conducting magnetic separation unit tests in a standardized manner.

In light of the FSMA (Food Safety Modernization Act), HAACP (Hazard Analysis & Critical Control Points) initiatives, and global standards like those put forth by BRC (British Retail Consortium), the importance of ensuring the performance of magnetic separation equipment goes without saying. What’s the right testing approach for your operation?
Magnetic Separation Unit Performance Inhibitors

Because magnetic fields are transparent to the human eye, measuring their strength requires specialized tools that measure the working air gap of the magnetic circuit. This is the area through which the products being inspected pass in proximity to the magnet. Thus, it’s critical that the magnet is continually able to seek, find, and pull metal objects from within the working air gap.

Fortunately, modern permanent magnets are just that—permanent. Unlike the magnets introduced to food production lines in the 1930’s, modern magnets boast an estimated loss of life equal to less than one half of one percent every 100 years. The archaic notion that a magnet will demagnetize on its own is completely unfounded.

However, the working air gap in food production facilities is subject to environmental conditions and activities that can potentially degrade the performance of the magnet or otherwise affect the magnetic field. Those include:

- **Abuse**, such as that which causes a fracture in the permanent magnet material within the separator assembly.
- **Contaminants**, which degrade performance if built up over time.
- **Electrical fields**, such as a welder.
- **Heat**, although the magnet will recover some of the loss when it cools down.
- **Moisture**, which can oxidize the mostly steel composition of rare earth magnets that are not properly sealed.

In a laboratory environment, taking good care to keep magnets clean, cool, dry, and free of abuse and electrical field interference will ensure the indefinite performance of the investment. Food production facilities, however, aren’t laboratory environments. Therein lies the necessity for standardized, scheduled testing of magnetic separation unit performance. While we can’t actually see the working air gap, we have to demonstrate that it’s effective for the application at hand. There are two approaches food manufacturers can take; gauss testing or pull testing.

Gauss Testing: An Academic Approach

In 1831, German mathematician and physicist Carl Friedrich Gauss developed the aptly named gauss, which has since become a standard unit of magnetic field measurement. It’s also known as “magnetic flux density” or “magnetic induction.”

Today, manufacturers of magnetic equipment rely on an electronic device that measures the strength of flux lines—the magnetic field we can’t see—within the working air gap of the magnet to determine its gauss profile. These electronic devices consist of a probe sensor attached to a handheld device by a cable. The probe is placed in the working air gap, where it measures lines of flux per square centimeter of the probe.

In clinical environments, where the working air gap can be plotted and the probe placed repeatedly in the exact same spot within the gap, gauss testing is incredibly accurate. That’s why manufacturers of magnetic separation
units leverage gauss testing, combined with finite element analysis software, to ensure their equipment produces the optimal gauss profile for the working air gap of the separator.

In real-world production environments, however, gauss testing has its limitations. Gauss profiles can change significantly dependent on the location within and angle at which the probe is placed within the gap in relation the line of flux travel. Because magnet circuits vary from one magnet to the next, and because humans are not precise, consistent, accurate readings are difficult to attain, making the manually-taken gauss value an imprecise determination of the magnet’s strength. Adding to the repeatable results challenge, magnetic separator tests are executed annually or biannually in most production environments. Because of the length of time that elapses between tests, it’s not uncommon for different individuals to execute them, which further challenges accuracy.

Finally, while modern electronic gauss testing devices are more reliable than the analog devices of yesteryear, they require manual recalibration between each reading, and any mechanical damage to the device’s cable will degrade its precision. Probe cables are essentially consumables that require regular replacement. These factors add time, cost, and technical training to the equation, as the way the device is handled and cared for has a direct impact on its accuracy and reliability.

Pull testing is advantageous because the test equipment is less expensive to acquire, more efficient to operate, and achieves more consistent, repeatable values than the gauss approach.

Pull Testing: Efficiency, Accuracy For The Real World
Just as gauss meters have evolved over the years, so have mechanical pull test units. As recently as the 1970s, pull test devices featuring simple spring loaded gauges that measure the force required to pull a small metal sphere or ball were the de facto standard of the industry. Akin to a fish scale, this minimalist device is still available today and popular among small, cost-conscious operations.

The modern and most popular pull test kit is a precision digital instrument that measures magnetic pull in any imperial or metric graduation. And, unlike both its spring-loaded predecessor and the modern electronic gauss meter, it’s automatically recalibrated after each read. Additionally, some manufacturers offer pull test devices with a maximum value readout feature to ensure the peak strength value is accurately recorded.

In practical applications, the pull test approach is advantageous because the testing equipment is less expensive to acquire, more efficient to operate, and achieves more consistent, repeatable values than the gauss approach, regardless of individual operator. The primary components of a pull test kit include the meter and a half-inch metal sphere welded to a stainless steel rod. With this setup, consistency between readings is guaranteed because the ball is drawn to the magnet’s peak energy point with every repetition of the test, as opposed to the gauss approach, which requires the operator to find the peak energy point within the working air gap using a probe. Thus, the pull test is also performed
much more efficiently than the gauss test, minimizing production downtime.

**Best Practices For Magnetic Separator Testing**
While it’s the position of MPI that the pull test is the most pragmatic and accurate approach to magnet separator testing in field applications, there are some important practices to consider regardless of test method.

- **Uniformity.** It’s critically important to establish uniform testing procedures, and in pull testing, that starts with the size of the steel object you’re measuring from. A quarter-inch sphere will produce a lower value than a half-inch sphere, and conversely, a 5/8 or one-inch sphere will produce a higher value. Because it’s important to use the same sized metal object and testing equipment to measure from one interval to the next during periodic inspections, we recommend choosing an all-inclusive, standardized test kit for all facilities.

- **Training.** Subscription services are available to ensure a certified professional conducts magnetic separator testing. When testing procedures are conducted in-house, operators should be thoroughly trained on the equipment by its manufacturer, and the test kit should include comprehensive directions.

- **Auditing.** Magnetic separation testing should be conducted in concert with regular equipment audits to ensure the fit and fitness of the unit. This should include a visual examination of gaskets, inspection for wear, abrasion, or other damage, and thorough cleaning, in addition to the ongoing assessment of the unit’s practicality for the use case.

- **Documentation.** Comprehensive and effective adherence to HACCP, BRC, and FSMA standards requires a standard protocol for detailed documentation of test results. The supplier of your magnetic separation equipment should demonstrate assistance with the development of standards appropriate for your production environment, and it should provide template forms to help meet your documentation criteria.

- **Collaboration.** A collaborative relationship with your magnetic separation equipment supplier will help ensure the standards you set will achieve the outcomes you desire.

At MPI, we realize that when we sell magnetic separation technology, we’re selling something our customers can’t see. It’s therefore incumbent on us to offer objective, easily-digestible education and training to help our customers make informed decisions about food safety initiatives within their unique manufacturing environments. We believe the best collaboration between end users and suppliers is based on common understanding of the products we manufacture and the objectives of our customers. For more information and additional resource material on modern magnetic separation technology for the food manufacturing industry, visit [www.mpimagnet.com](http://www.mpimagnet.com).
About MPI

Based in Metro-Detroit Michigan, MPI designs, manufactures and services magnets, material handling and electronic inspection systems. MPI products are designed to be complete metal and foreign contamination control solutions for the food production and related industries. MPI’s equipment and service programs help its customers minimize downtime and protect brand integrity through offering safe and reliable equipment.

MPI leads the industry by continuously engineering inventive products, advancing customer education through significant investments in research and development, and proactive product training. All MPI equipment is backed by its best in class service programs, customer service team, and support team. MPI interacts closely with its customers and expands its offerings to meet the changes of a dynamic and ever changing marketplace.