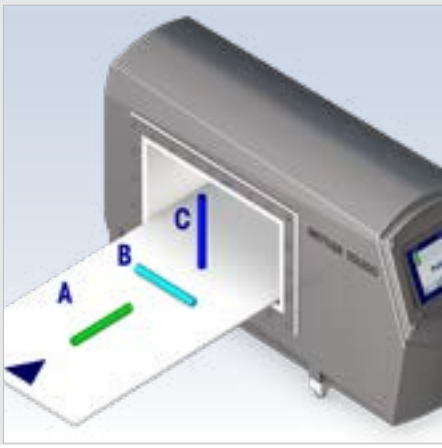
Understanding Sensitivity In Metal Detection

Maximize Performance Of Your Metal Detector



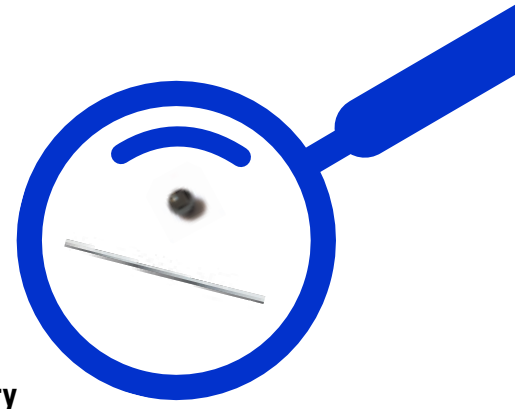
METTLER TOLEDO

Sensitivity Is A Key Contributor
To Metal Detection Effectiveness

There are a number of factors that affect the sensitivity of a metal detector and the ability to find different types of metal. It is important to understand these factors to get the most out of your metal detection program.

This guide explains the concept of metal detector sensitivity, key factors that affect it, and why a small difference in spherical sensitivity performance can mean a big difference in the length of wires or other irregular-shaped contaminants that can be detected.

What Is Sensitivity?
How Is It Measured?



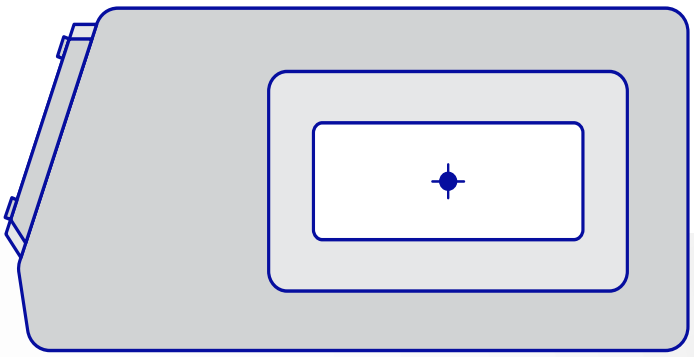
Sensitivity is the measure of a metal detector's ability to detect a specific type and size of metal contaminant. The better the sensitivity of the metal detector, the smaller the pieces of irregular-shaped metal it can detect.

Metal detector performance is usually expressed by the diameter of a test sphere made from a specific type of metal, such as ferrous, non-ferrous (aluminum, brass), or stainless steel.

Sensitivity should always be measured as near to the center of the metal detector's aperture as possible, as this is the least sensitive point. When comparing the performance of different metal detectors, the clear winner is usually the one with the best spherical sensitivity across all metal types, when measured in the center of the aperture.

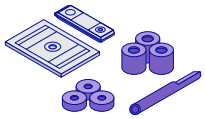
However, in some cases, it may not be so clear. One metal detector could outperform the other on one metal type, and vice versa for another. In this case, you should consider which contaminant type is most likely to occur (often this is stainless steel) and could base your decision on which system performs best for this metal contaminant type.

Ultimately, it is best to discuss the situation with a metal detection system expert who can guide you through the process of choosing the best overall system, as there are many other factors to consider.



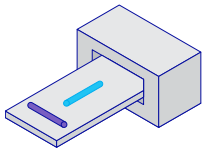
Factors That Contribute
To Metal Detector Sensitivity

When measuring the sensitivity of a metal detector, a test piece must be reliably detected and rejected when passed through the center of the aperture of the metal detector. However, there is a significant difference between the test piece's spherical sensitivity and the actual length of an irregular-shaped or wire-type contaminant that can be detected. A number of factors can affect the sensitivity of a metal detector. An experienced provider can help you select the right solution to overcome these challenges.



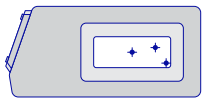
Metal type

A HACCP audit may identify a risk of various metal types, including ferrous, non-ferrous and stainless steel. However, the sensitivity of the metal detector can vary depending on the type of metal contaminant present. Typically ferrous is the easiest to detect, and stainless steel is the hardest to detect. However, as with many "rules" there are exceptions to this.



Orientation effect

A metal detector's ability to identify a non-spherical contaminant such as wire or swarf, is partially determined by the type of metal contaminant (ferrous, non-ferrous or stainless steel), as well as the metal object's orientation. Orientation effect becomes a limiting factor when the contaminant's cross-sectional area (i.e. diameter of a wire) is less than the metal detector's spherical sensitivity.



Aperture size and product position

To maximize sensitivity, the smallest possible aperture size should normally be used. Optimum aperture size will be dependent upon the products being inspected, and in the case of conveyorized inspection, the dimensions and orientation of the product on the belt.

Packaging material

The packaging material used to pack a product can affect sensitivity if the material is itself conductive. The production process should be assessed to determine the best inspection point. In some cases this may be immediately prior to packing. In other cases, e.g. when metalized film is used, several alternatives are available, including alternative/multiple frequencies or using a slightly larger aperture. The ultimate critical control point (CCP) is after final packaging.

Environmental conditions

Factory conditions can also affect the metal detector's performance. It is important to use a metal detector which has built-in Noise and Vibration Immunity to minimize the risk of airborne electrical interference and local plant vibration affecting the metal detector's performance.

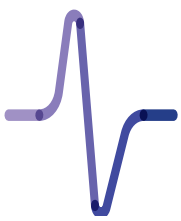
Product characteristics

Some products are electrically conductive or magnetic and as such behave in the same way as metal when passing through the detector. For example, products with high moisture or salt content such as meat and poultry, exhibit this phenomenon, often referred to as 'product effect'. The latest innovative metal detection solutions combine two or more frequencies simultaneously along with Product Signal Suppression technology to overcome this issue by minimizing the active product signal.

Process speed

This is not necessarily a limiting factor for most metal detection systems. However, it is important to ensure the metal detector can operate at optimal performance levels, taking into account any potential variations in speed or product throughput on the line.

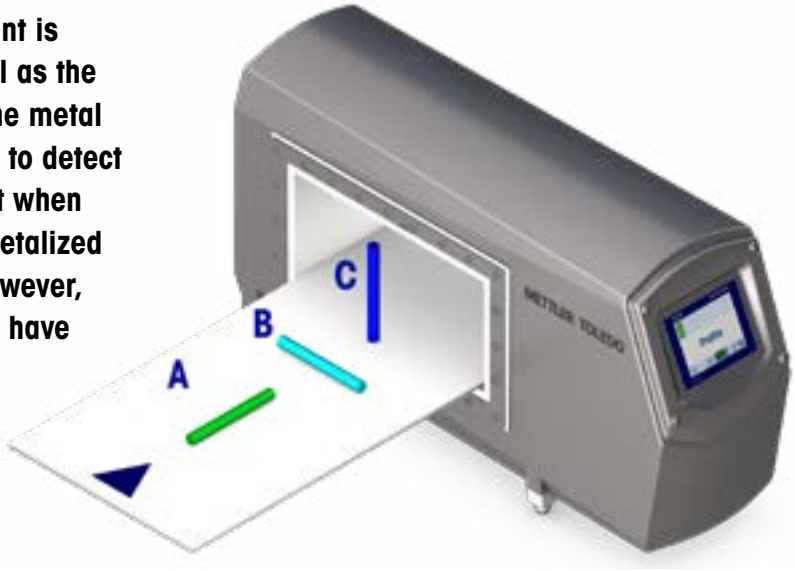
Detector frequency



Metal detectors can be run on different operating frequencies – the optimum frequency depends on the type of product being inspected. For dry products such as snack foods, metal detectors are more effective at high, tuned frequencies, but for wet products such as meat and poultry, a combination of Multi-Simultaneous Frequency and Product Signal Suppression technology is recommended to get the best results, while also minimizing false reject rates.

How Direction Of Travel
Can Lead To Orientation Effect

A metal detector's ability to identify a contaminant is partially determined by the type of metal, as well as the contaminant's orientation as it passes through the metal detector. In reality, all metals are relatively easy to detect in dry product applications – but harder to detect when inspecting wet products, or those packaged in metalized film due to the product's own characteristics. However, recent innovations in metal detection technology have made it possible to overcome this challenge.



	Contaminant	Ferrous (FE)	Non-Ferrous (Non-Fe)	Stainless Steel (SS)
Characteristics	Magnetic Permeability	Magnetic	Non-magnetic	Usually non-magnetic
	Electrical Conductivity	Good electrical conductor	Generally good or excellent	Usually poor conductors
	Ease of Detection in Wet Applications	Relatively easy to detect	Harder to detect in wet applications due to being non-magnetic*	Relatively difficult to detect due to being non-magnetic and a poor conductor*

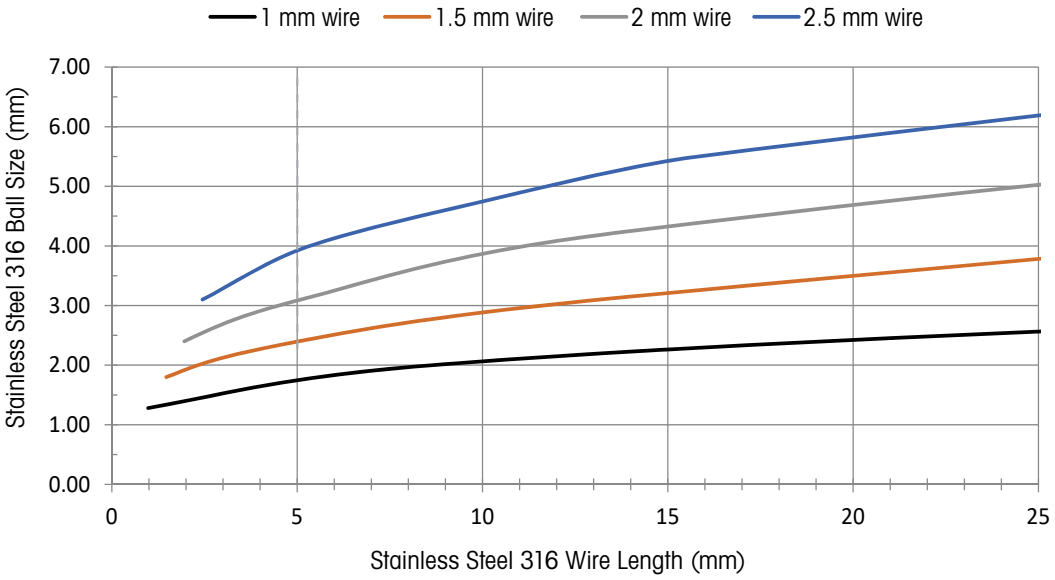
		Relative Ease of Detection When Orientation Effect Is Observed:		
Orientation	Position A	Easy	More Difficult	More Difficult
	Position B	More Difficult	Easy	Easy
	Position C	More Difficult	Easy	Easy

*Note: Using the latest metal detection technology means the detection of Non-Fe and SS metals has become considerably easier. Product testing is highly recommended to establish likely sensitivity levels for a specific application.

A Small Change In Spherical Sensitivity – A Big Difference In Wire Length Detection

Operating at the highest spherical sensitivity level will provide maximum protection to your brand and company's reputation, dramatically improving your detection capability to real life contaminants such as wires and swarf. As the chart below shows, improving detection sensitivity by 25% (going from a ball size of 2.0 mm to 1.5 mm for example) will significantly improve the length of the wire that can be detected, and decrease the risk of undetected metal reaching, and potentially causing harm to, consumers.

Detectable Stainless Steel 316 Wire Results (All Orientations)
For Dry Product Inspected at High Frequency



Stainless steel is used in this example since it is typically more difficult to detect than ferrous and non-ferrous metals.

The FDA states that a hard or sharp foreign object measuring between 7 mm to 25 mm in length may cause a traumatic injury or present a choking hazard*.

*FDA choking hazard: http://www.fda.gov/ICECI/ComplianceManuals/CompliancePolicyGuidanceManual/ucm074554.htm

Results shown in the above chart will change when inspecting wet/conductive products and/or if using low or mid-range frequency metal detectors. In challenging applications – where products contain high moisture or salt content, are subject to varying temperatures, or are wrapped in metallized film – sensitivity performance will generally be worse than for dry products. Achieving the best possible sensitivity requires use of the latest metal detection technology specifically for these challenging applications.

Expert Support
METTLER TOLEDO offers in-house product testing to give you an indication of the sensitivity results that can be achieved on your products. Contact us to request a test today.

Factors That Lead To
Product Effect In Metal Detection

Product effect occurs when a product's own characteristics inhibit the inspection device's ability to distinguish between the product being inspected, and a particular contaminant type. Often referred to as a 'challenging application', this can result in potentially high false reject rates, unless the technology in use is able to overcome product effect using innovative software algorithms.

Six key factors that contribute to product effect are highlighted below.

1 Product temperature

2 Moisture or salt content

3 Product format

4 Product consistency

5 Orientation on the production line

6 Product size and shape

How To Find Smaller Metal Contaminants
For Better Brand Protection

To protect your customers, maximize efficiency and meet industry standards, manufacturers and processors have an important role to play in identifying, implementing and maintaining an optimum level of metal detector sensitivity.

Metal detectors may use a range of different technologies to suit the product being inspected. For example:

- The optimum technology for inspecting dry products such as snack foods is a metal detector with ultra high-tuned frequency. This will deliver exceptional sensitivity to detect smaller pieces of metal.
- In challenging applications with product effect – where products are hot, wet, chilled or cooling – a metal detector with dual or multi-simultaneous frequency and Product Signal Suppression technology is more effective than tuned technology.

Choosing a stable, reliable metal detector that delivers enhanced sensitivity levels is an integral part of a food safety program to minimize metal contamination going undetected. However, having a metal detector is not enough – it must also be correctly installed, operated and maintained for optimal performance.

When To Test
Your Metal Detection Equipment

Routine performance testing is essential to meet the requirements of food safety standards and retailer codes of practice.

The frequency of testing should consider the following stages:

- At the start and finish of daily production / shifts
- At regular intervals during the production run
- At changes in production batches
- After changes to machine settings
- After downtime for repairs

It is also important to take into consideration the quarantine (or on-site storage) period for the products being produced. This is to ensure all products inspected since the last successful test can be easily recalled in the event of a failed test, to minimize the cost of a product recall.

Validation, Verification And Monitoring
Ensuring Correct Equipment Performance

Validation, verification and monitoring are distinct processes. Each has a clear purpose and role to play at different points within the equipment lifecycle.

Validation is the initial qualification of a product or process against the stated design specification and aims to answer the question "will this piece of equipment meet the specified objectives?"

Re-validation may also be required if substantial modifications to the equipment, or the products being inspected (size, packaging material, etc.) are made at any point after installation. The equipment manufacturer should be able to offer you expert guidance on this process.

Verification is the periodic qualification that the equipment continues to be effective. It uses standard, formal processes to answer the question "is the specified equipment under control and operating as expected?" Best practice is to use a third party – ideally the equipment manufacturer or the manufacturer's representative – to conduct your annual performance verification. METTLER TOLEDO's qualified service technicians can support you with this to make compliance easier.

Routine performance monitoring (or "monitoring" for short) differs from the processes of validation and verification in that it is a series of performance checks completed at frequent, regular intervals by a trained operator. These checks are designed to determine if processes are under control. METTLER TOLEDO offers operator, quality and maintenance-level training to ensure your staff understand how to correctly perform these tests.

Download the White Paper **"Validation, Verification and Monitoring for Product Inspection Equipment"** for a detailed overview of each process.

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Increase Your Understanding
Of Metal Detector Testing

Looking to understand more about how to test your metal detector to ensure you comply with food safety standards and retailer codes of practice? METTLER TOLEDO has produced a guide on "How to Correctly Test Your Industrial Metal Detector." This document highlights key differences between validation, verification and routine monitoring; explains test processes for different types of metal detectors; offers guidance on retailer requirements; and explains recent innovations that make routine testing processes easier.

Request your FREE guide on
"How to Correctly Test Your Metal Detector." Visit:

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