

# Practical Tips For Metal Detection Selection

## 1 How Does it Work?

The Basics of Metal Detection

---

## 2 Different Types of Contaminant

Sensitivity Explained

---

## 3 The Importance of Frequency

In Metal Detection

---

## 4 Overcome Product Effect

To Reduce False Rejects

---

## 5 Other Important Considerations

To Maximize Performance



**METTLER TOLEDO**

# Contents

	<b>Introduction</b>	
	<b>Going Beyond Metal Detection</b> . . . . .	<b>3</b>
<b>1</b>	<b>How Does a Metal Detector Work?</b>	
	<b>Key Principles</b> . . . . .	<b>4</b>
1.1	Balanced Coil Metal Detectors . . . . .	4
1.2	Sources of Metal Contamination . . . . .	5
1.3	Front-end Detection . . . . .	6
1.4	Inspecting For Metal Contaminants In-Process . . . . .	6
1.5	Detecting Metal Contamination at End-of-line . . . . .	6
<b>2</b>	<b>Different Types of Contaminant</b>	
	<b>Sensitivity Explained</b> . . . . .	<b>8</b>
2.1	Spherical Sensitivity Explained . . . . .	8
2.2	Orientation Effect and the Impact on Sensitivity . . . . .	10
2.3	Position of Metal in Aperture . . . . .	11
2.4	Shape of Metal . . . . .	12
<b>3</b>	<b>The Importance of Frequency</b>	
	<b>In Metal Detection</b> . . . . .	<b>14</b>
3.1	What is the Best Operating Frequency? . . . . .	14
3.1.1	Dry Products . . . . .	14
3.1.2	Wet Products . . . . .	14
3.1.3	Deep Frozen vs Thawing Products . . . . .	15
3.1.4	Metalized Film Packaging . . . . .	15
3.2	Frequency Options and Detection Capabilities Compared . . . . .	16
3.3	Frequencies . . . . .	16
3.4	State of the Art Technology . . . . .	19
<b>4</b>	<b>Overcome Product Effect</b>	
	<b>To Reduce False Reject Rates</b> . . . . .	<b>20</b>
<b>5</b>	<b>Other Important Considerations</b>	
	<b>To Maximize Performance</b> . . . . .	<b>22</b>
5.1	Productivity Considerations . . . . .	22
5.1.1	Ease of Operation . . . . .	22
5.1.2	Reduce Costly Waste . . . . .	22
5.1.3	Minimizing Potential Downtime . . . . .	23
5.2	Environment Considerations . . . . .	24
5.2.1	Construction Standards . . . . .	24
5.2.2	Protection From Environmental Interference . . . . .	24
5.3	Compliance Considerations . . . . .	24
5.3.1	Documenting and Storing Test Results . . . . .	24
5.3.2	Performance Verification and Monitoring Support . . . . .	24
5.3.3	Operator Training . . . . .	25
5.4	Service Support Considerations . . . . .	25
<b>6</b>	<b>Summary</b>	
	<b>Not All Metal Detectors are the Same</b> . . . . .	<b>26</b>
<b>7</b>	<b>Key Considerations</b>	
	<b>Checklist for Comparing Solutions</b> . . . . .	<b>27</b>
	Increase Your Understanding	
	of Metal Detector Sensitivity . . . . .	28

# Introduction

## Going Beyond Metal Detection

**Food and non-food manufacturers have to be able to meet the requirements of Hazard Analysis and Critical Control Points (HACCP) and the broader needs of industry regulations and standards, without the worry of generating costly false rejects and unnecessary product waste. And perhaps more importantly, avoiding product recalls. The right metal detection technology makes it possible to move beyond simply detecting and rejecting metal, to support productivity, compliance and brand protection aims.**

Achieving metal-free products depends as much on the effectiveness of the detection technology as on the selection of the best critical control point (CCP). In some cases this may mean using a metal detection solution at multiple CCPs. The challenge lies in being able to consistently detect and accurately reject the smallest possible metal contaminants in any product.

Choosing the right metal detection system depends partly on selecting the best frequency technology for the application to consistently achieve the required sensitivity performance without a high volume of false rejects. However, other factors should also be taken into consideration. These factors include:

- Productivity aims
- Environment considerations (cleaning regimes and the solution's level of immunity to noise and vibration interference)
- Compliance needs (industry standards and retailer codes of practice)
- Reliable service support

This guide seeks to eliminate widespread confusion, help explain the options available to suit specific needs and provide guidance on questions you should be asking when choosing a new metal detection system.

Understanding how the technology works, and the capabilities different solutions have to support wider productivity and compliance needs can help you to make an informed decision to maximize your return on investment. At the end of this guide, we have included a checklist to use when comparing solutions from different suppliers.

# 1. How Does a Metal Detector Work?

## Key Principles

The most common type of industrial metal detector uses a balanced coil system design.

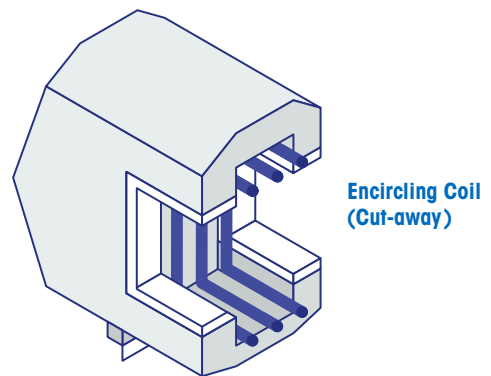
### 1.1 Balanced Coil Metal Detectors

Basically, a metal detector consists of three coils that are said to be "balanced". These coils are typically made up of copper wire wound around a non-metal former to create three parallel loops through which the product is passed (Figure 1).

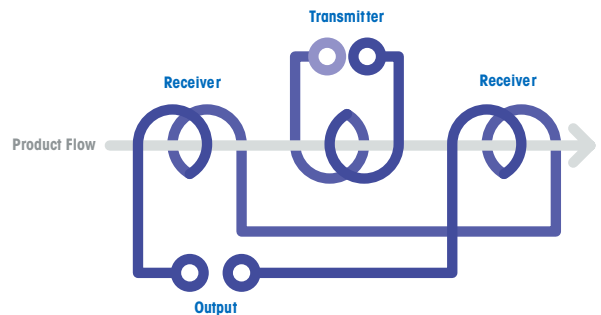
- Center coil is the transmitter
- Outside coils are receivers

The center coil is energized with a high frequency current that generates a magnetic field. The two outer coils (receivers) pick up the generated field and are connected in opposition to each other and as such create a perfect electrically balanced field.

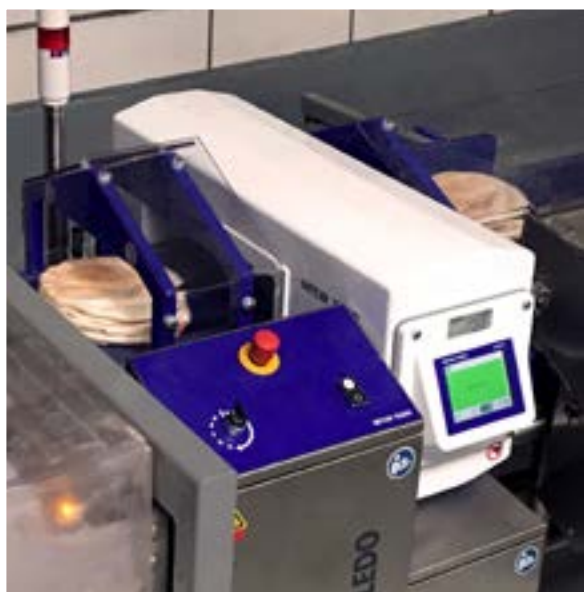
When a metal particle, or anything that is magnetic or electrically conductive, is passed through the detector aperture (Figure 2), it interferes with the magnetic field, causing a signal to be detected by the receiver coils. The metal detector evaluates this signal and confirms there is metal present.



**Figure 1:** Balanced coil system inside the metal detector head



**Figure 2:** Balanced three coil system



## 1.2 Sources of Metal Contamination

Any metal that is introduced during the production process or is present in the raw material, may cause production downtime, serious injuries to consumers or damage other production equipment. The consequences can be serious and can include costly compensation claims and product recalls that damage brand reputation. There are a number of ways that that products can be contaminated with metal:



Inclusion in raw materials (e.g. barbed wire, fish hooks, veterinary needles)



Accidentally being introduced by employees (e.g. personal effects)



Maintenance procedures taking place on or near the production line



Equipment malfunction or breakage during the manufacturing and packaging processes (sieve wire, broken cutting blades, etc.)

## Maximize Stability and Reliability!

Maximizing balance stability along with noise and vibration immunity will deliver the most stable platform for long term operation, and will help to minimize false rejects.

METTLER TOLEDO Safeline metal detectors are designed to deliver market-leading stability and reliability, thanks to innovative potting processes to prevent unnecessary movement of the balanced coil system and in-built technology to minimize environmental interference.

When comparing possible solutions, it's important to ask about features that deliver long-term reliability. METTLER TOLEDO Safeline metal detectors offer innovations such as:

- Environmental Noise Immunity (ENI)
- Environmental Vibration Immunity (EVI)
- Auto Balance Control
- Dynamic Stability Control™

Working with a partner who understands the specific requirements of an integrated metal detection system, including avoidance of earth loops and the metal free zone, will minimize risks of unplanned downtime and reduce the likelihood of false rejects.



## 1.3 Front-end Detection

In many production processes raw and incoming materials are inspected before being mixed and blended with other ingredients or processed further. Detecting contaminants early in the production process has many benefits:

- The material can be more homogeneous and easier to inspect
- Contaminants tend to be larger and easier to detect
- It helps protect valuable downstream processing equipment from damage
- Eliminates the contaminants before additional production value has been added, minimizing wastage

## 1.4 Inspecting For Metal Contaminants In-Process

Inspecting bulk or loose-flow product before packaging may be a preferred option to minimize the risk of any metal contaminants in the final product. This CCP inspection point is commonly used for a wide variety of products including:

- Sugar, flour, grains, cereals, pulses and coffee beans
- Extruded snacks, chocolate and confectionery
- Baked goods (freshly baked bread, bread rolls)
- Dairy products (cheese, ice cream, yogurt)
- Liquids, pastes and slurries (soups, sauces, molten chocolate)
- Nuts; dried, fresh or frozen fruits and vegetables
- Individually Quick Frozen products (such as seafood, fruit and vegetables)
- Meat, poultry, fish



## 1.5 Detecting Metal Contamination at End-of-line

Final inspection of products at the end of the production line is the last line of defense to detect any metal contamination and remove the non-conforming product before shipping to retailers and supermarkets. The type of packaging being used and the potential type of contamination may dictate the type of foreign body detection system used at this CCP.

Typical products inspected by metal detection systems at end-of-line include:

- Ready meals
- Individual trays of meat
- Wrapped baked goods
- Dairy products (excluding those with foil lids or packaging)



## 2. Different Types of Contaminant Sensitivity Explained

The most common types of metal contaminant in food and pharmaceutical manufacturing are ferrous, non-ferrous and various grades of stainless steel. Of these, ferrous metal is typically the easiest to detect, whilst stainless steel is the most difficult to detect, particularly the most common grades such as 316 and 304. Each has differing magnetic and conductive properties, which affects how easy or relatively difficult it is to detect (Table 1).

### 2.1 Spherical Sensitivity Explained

Different metal detectors offer different degrees of sensitivity performance. Sensitivity is the measure of a metal detector's ability to accurately and consistently detect a specific type and size of metal contaminant. Operating with the best spherical sensitivity can dramatically improve detection capability for real life, non-spherical metal contaminants such as wires and swarf (a fine piece of metal from machining operations).

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.

Metal Type	Magnetic Permeability	Electrical Conductivity	Ease of Detection
<b>Ferrous (Iron)</b>	Magnetic	Good	Easily detected
<b>Non-Ferrous (Copper, Brass, Lead, Aluminum)</b>	Non-magnetic	Generally good or excellent	Relatively easily detected
<b>Stainless Steel (Various Grades)</b>	Usually non-magnetic	Usually poor	Relatively difficult to detect

**Table 1:** Metal types and relative ease of detection



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 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.

## Did You Know?

A true comparison of performance can only be made when tests are conducted in the production environment, ideally where the unit will ultimately be situated.

It may be worth enquiring if your supplier has a rental system available that will allow you to try before you buy.

If that is not possible, your supplier may offer the option of conducting product tests in their own facility using your product, which will give you a good indication of the performance level you can expect.

Contact your local METTLER TOLEDO sales representative to discover the many ways we can support your decision making process to ensure you make a smart investment in the right solution for your application.

## 2.2 Orientation Effect and the Impact on Sensitivity

As discussed in the previous section, the type of metal partially determines a metal detector's ability to identify a contaminant. However, the metal object's orientation as it passes through the metal detector can also have an impact. 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.

In reality, all metals are relatively easy to detect in dry product applications, but harder 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. Product testing is highly recommended to establish likely sensitivity levels for a specific application.

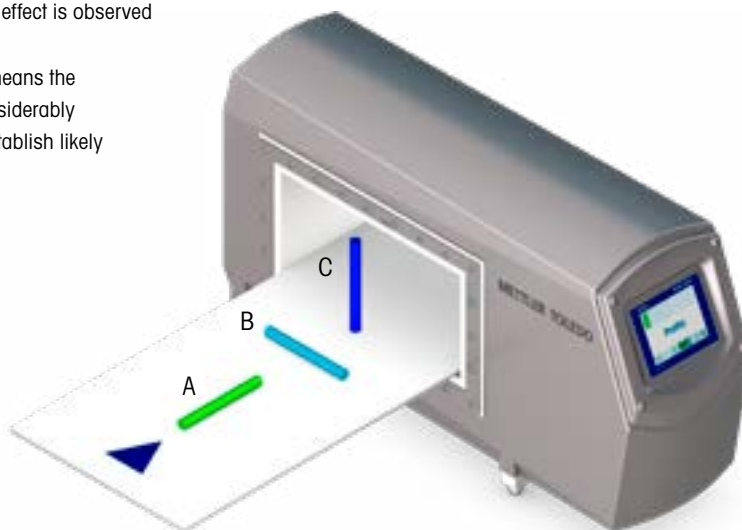
If a non-spherical particle of metal, such as swarf or wire passes through a metal detector, it will be easier to detect when passing in one particular orientation, compared to another orientation if the object's diameter is less than the spherical sensitivity standard for that metal type. This is known as the orientation effect.

Ferrous contaminants are easier to detect when they are presented in an orientation parallel to the direction of travel "A" (Figure 3). However, they are much more difficult to detect than stainless steel when they are at right angles to the direction of flow "B". Non-ferrous metals are exactly the opposite (Table 2).

		Ferrous	Non-ferrous	Stainless Steel
Orientation	Position A	Easy	More Difficult	More Difficult
	Position B	More Difficult	Easy	Easy
	Position C	More Difficult	Easy	Easy

**Table 2:** Relative ease of detection when orientation effect is observed

\*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.



**Figure 3:** Contaminant orientations A, B, and C



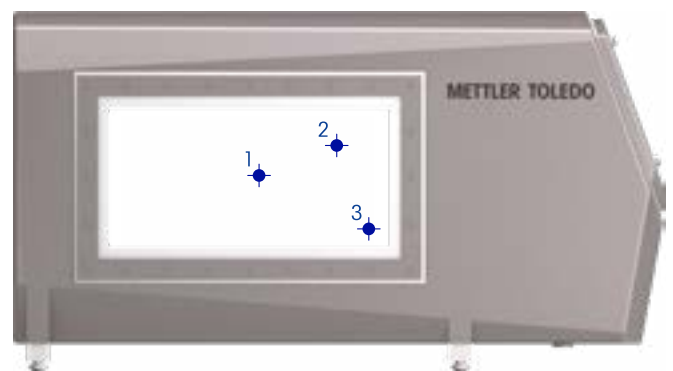
Sometimes, to maximize detection capabilities, the best solution is to install multiple metal detection systems at different angles to overcome orientation effect challenges.

### 2.3 Position of Metal in Aperture

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. Both aperture width and aperture height have an influence on the detector's sensitivity, but changes in the aperture height (or the smaller aperture dimension) will have a greater effect.

Figure 4 shows a typical tunnel metal detector for conveyorized applications.

The geometric center (position 1) is the least sensitive part of the detector, whilst the corners are the most sensitive (position 3). All other points will lie somewhere inbetween (e.g. position 2). This is known as the "sensitivity gradient", and will depend on the design and assembly of the coil system.



**Figure 4:** Sensitivity gradient



## 2.4 Shape of Metal

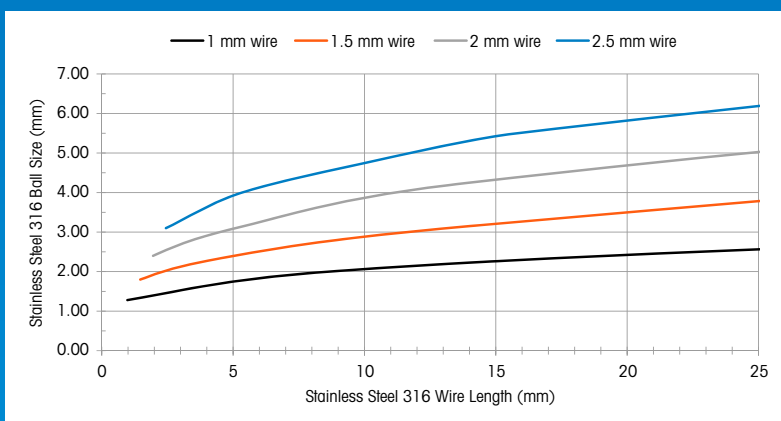
Orientation effect is only evident when the diameter of the wire is less than the spherical sensitivity of the metal detector.

Thus, a small change in spherical sensitivity (ball diameter) will make a great difference to detection capability with respect to wire pieces.

This is illustrated in Table 3, for example:

- At 2.5 mm spherical sensitivity, a piece of stainless steel wire that is 1.0 mm in diameter would need to be 22.7 mm long to be detected in all orientations
- When operating at 2.0 mm spherical sensitivity, a piece of stainless steel wire that is 1.0 mm in diameter would need to be only 8.2 mm long to be detected in all orientations

Clearly, if wire is identified as a potential contaminant, it is best to operate the detector at the highest possible sensitivity. However, as sensitivity levels increase, the problems of stability become more acute, and with some detectors, nuisance false rejects will increase to an unacceptable level. Consequently, the design of the metal detection system becomes more important.



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

**Table 3:** Detectable stainless steel 316 wire results (all orientations) for dry product inspected at high frequency



A difference in spherical sensitivity of 0.2 mm to 0.5 mm may not sound like a lot, but when you equate this to the capability of each system to detect non-spherical or irregular-shaped contaminants, the difference can be significant.

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.

\*Read more:

► [FDA choking hazard](#)



## 3. The Importance of Frequency In Metal Detection

The operating frequency of a metal detector is a key factor in determining how well metal can be detected. In technical terms, the frequency is the rate of electromagnetic waves (measured in kHz) emitted by the metal detector transmitter coil. Metal detection systems are designed to operate at a variety of frequencies, from as low as 25 kHz up to 900 kHz. In the context of metal detection, anything >800 kHz is classed as ultra-high.

### 3.1 What is the Best Operating Frequency?

Unfortunately there is no "one size fits all" frequency to detect any type, size or shape of metal. The most effective frequencies will vary depending on the product or application (Table 4). Higher and lower frequencies each have their own advantages, depending on the metal contaminant and product(s) being inspected.

Understanding the advantages and disadvantages and what the metal detector will be used for, can help you evaluate the best metal detector system for your needs. This allows a greater confidence that the products sent into the supply chain are free from even the smallest metal contaminants.

#### 3.1.1 Dry Products

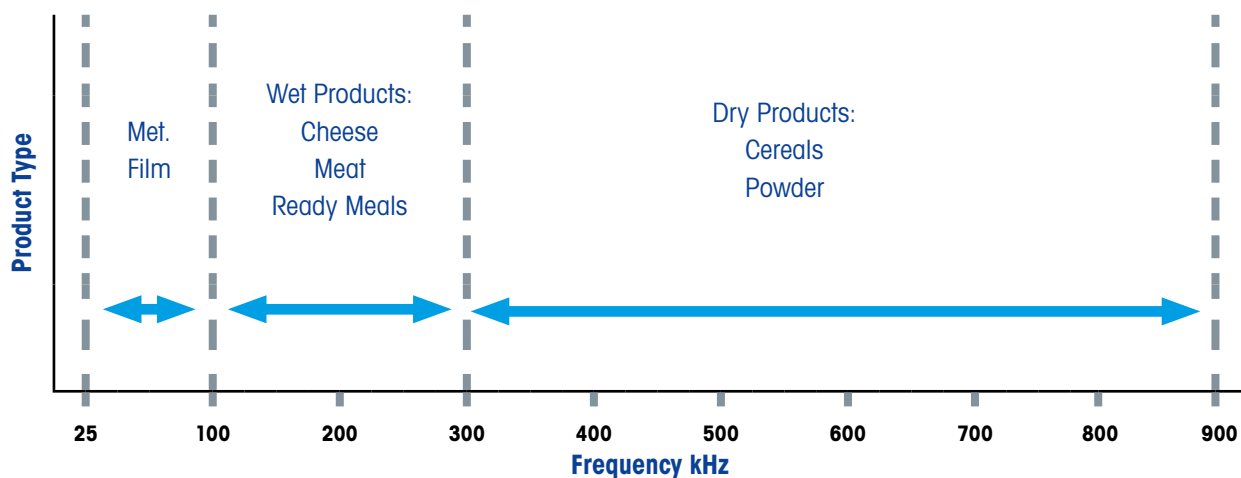
"Dry" is a catch-all term for food, non-food and pharmaceutical products that respond well to inspection by a metal detector. These non-conductive products such as tablets, fine powders, cereals, confectionery, sugar, flour, dried pasta, and biscuits are easier to work with because they do not generate false or ambiguous signals in the metal detector. They have a low product effect and can be inspected at high frequencies.

#### 3.1.2 Wet Products

Wet, conductive products create a product effect and are more challenging to inspect. Fresh meat, poultry, fish, seafood, freshly baked goods, jams, ready meals and dairy products create a much higher signal than dry products. If the frequency is set too high, this product (background) signal can trigger the detector, resulting in false rejects and unnecessary product waste.

Conversely, attempting to control false rejects by reducing detector sensitivity allows more products to pass, but increases the risk of products containing metal contaminants going undetected and reaching the end consumer.

A further challenge comes when inspecting mixed products, such as ready meals, as the different component ratios present a different conductivity than a single piece of boneless beef, which is in turn different from a bone-in piece of beef.



**Table 4:** Product characteristics and frequency

### 3.1.3 Deep-frozen vs Thawing Products

Deep frozen and thawing products can often be a challenge when selecting the right metal detection system. Deep-frozen products typically act like a dry product, however, as frozen products thaw when exposed to warm, damp air, condensation forms on the outer packaging which creates a product effect. Thawing converts a dry product into a wet one.

This changing of product signal requires a solution for high product effect to get the best results. An even greater effect is the way that changes in temperature alter the phase angle of the voltage in the metal detector's receiver coils. A change of just 5 °C will create a shift in phase angle that's significant enough to make detection of contaminants much harder.

### 3.1.4 Metalized Film Packaging

Products packaged in metallized film - such as chocolate bars, nuts and potato chips - can have a big impact on achieved sensitivity. The thin layer of aluminum metal in the packaging creates a product effect. This needs to be overcome to detect small metal contaminants accurately and consistently.

### 3.2 Frequency Options and Detection Capabilities Compared

Technology capabilities, for the purpose of this guide, are based on single, dual and multi-tuned frequencies and multiple simultaneous frequencies combined with an intelligent inspection algorithm.

The degree of future-proofing depends on the relative flexibility of a particular solution to inspect a wide range of products with different characteristics (Table 5).

When it comes to frequencies, how they are combined and managed is more important than how many frequencies are available, for improving detection accuracy. When a metal detector has multiple frequencies that are untuned, the results - especially when inspecting dry products - are likely to be average at best when compared to a metal detector with 2 or 3 high frequencies that are tuned.

Technology	Number of Frequencies Available	Dry Product Sensitivity	Wet/Challenging Product Sensitivity	Future Proofing
Tuned, single, low to mid-range frequency	1	***	***	*
Tuned, single, high range frequency	1	*****	**	*
Tuned, dual, low range frequency	2	**	***	***
Tuned, dual, high range frequency	2	*****	**	***
Tuned, multiple, low range frequency	3	***	***	*****
Tuned, multiple, high frequency	3	*****	**	*****
Multi-Simultaneous with Intelligent Inspection Algorithm	6	**	*****	*****

**Table 5:** Product characteristics and frequency

\* = Poor, \*\* = Average, \*\*\* = Good, \*\*\*\* = Very Good, \*\*\*\*\* = Excellent

### 3.3 Frequencies

For dual and multi-frequency solutions, care should be taken to ensure performance is not compromised at each individual frequency when compared to a detector tuned for single frequency operation.

This is especially important for the frequencies that are commonly selected for dry product / high sensitivity applications. The pros and cons of the frequency option selected need to be carefully considered (Table 6).

Multi-Simultaneous Frequency on its own is not enough to deliver very high sensitivity performance for all metal types in wet or challenging product effect applications.

However:

- When combined with an intelligent inspection algorithm (such as METTLER TOLEDO Safeline's 3S algorithm), the results suggest these are generally the most sensitive metal detection systems for these applications
- They use data captured at each frequency to generate a detection algorithm. In basic terms, a picture of the product is built up
- The use of Multi-Simultaneous Frequency technology combined with Product Signal Suppression techniques minimizes the product effect signal to virtually eliminate false rejects

As a general rule, when inspecting dry product, tuned frequencies obtain >10 % better sensitivity than untuned frequencies.

### Did you know?

Metals are not the only materials that have the ability to conduct electricity and generate magnetic fields. There are many naturally high, product effect (wet) applications due to high moisture or salt content, or varying temperature i.e. fresh meat, chicken, fish and freshly baked bread, along with metallized film.

These products are likely to produce a signal in the metal detector in the same way as small metal contaminants would. We call this product effect.

**Frequency Options - The Pros and Cons**

<b>Technology</b>	<b>Advantages</b>	<b>Disadvantages</b>
<b>Tuned, Single Frequency</b>	<p>Very effective for inspecting dry products such as fine powders, cereals, dried pasta or confectionery. Suited to detecting the same product day in day out, e.g. chocolate bars.</p> <p>Can detect all metals, but is optimized for ultra high frequency at &gt;800 kHz for stainless steel. If the main contaminant risk is ferrous, 300 kHz frequency would be more suited.</p>	<p>Difficult to deal with challenging applications, such as wet (conductive) products, or those that vary in temperature.</p> <p>Limited future proof options when there are variations in products or product line changes occur.</p>
<b>Tuned, Multiple Frequencies</b>	<p>Operates on more than one frequency, with the added flexibility of two or more frequency options between the ranges of 25 kHz and 900 kHz.</p> <p>Suitable for different types and sizes of products to be inspected, such as dry or wet products on the same production line.</p> <p>Future-proofing to meet product demands as and when they arise.</p> <p>Delivers greater sensitivity performance for a wider range of applications.</p>	<p>When product effect is present there can be a trade-off between the product effect, the maximum operating frequency and metal detector sensitivity.</p> <p>Creates a compromise between sensitivity (detecting the contaminant) and avoiding false rejects.</p> <p>Traditionally the solution for product effect was to turn down the frequency. However this increases the risk that some metal contaminants could reach retail shelves. With the introduction of Multi-Simultaneous Frequency with an intelligent algorithm, this is avoided.</p>
<b>Multi-Simultaneous Frequency With Intelligent Inspection Algorithm</b>	<p>Detection sensitivity is dramatically increased on wet products, including those packaged in metallized film, that has previously only been obtainable on dry products, especially in stainless steel detection.</p> <p>The smallest contaminant detection is possible.</p> <p>Dramatically reduces product effect and minimizes false rejects.</p> <p>Reduces the risk that good product will be rejected and wasted, helps to prevent contaminated products from reaching the end consumer.</p>	<p>Dry sensitivity is reduced and not as effective as tuned, multi, high frequency range.</p>

**Table 6:** Frequency evaluation

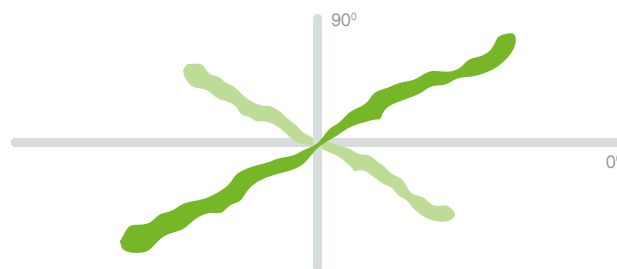
### 3.4 State of the Art Technology

Multi-Simultaneous Frequency combined with Product Signal Suppression technology effectively deals with product variations which historically have been the cause for a high false reject rate in wet or challenging product effect applications (Figures 4a), or a reason to reduce the metal detector's operating sensitivity.

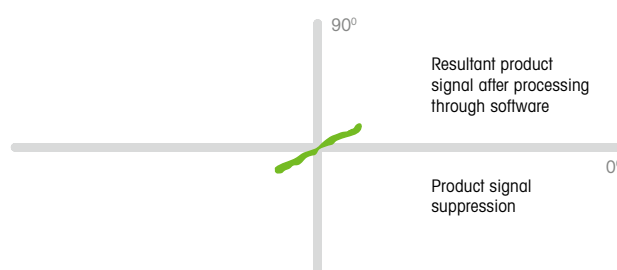
Once a detector has been set up to inspect a particular product, the product signal suppression technology is applied to each product that passes through the detector. This is shown in Figures 4b and 5 and Table 7.

The improvement in spherical sensitivity performance, from the traditional single frequency metal detectors is as much as 50 % in product effect or metalized film applications. False triggering is virtually eliminated, with a higher level of confidence that the smallest amount of metal contaminant can be detected and removed from the production line.

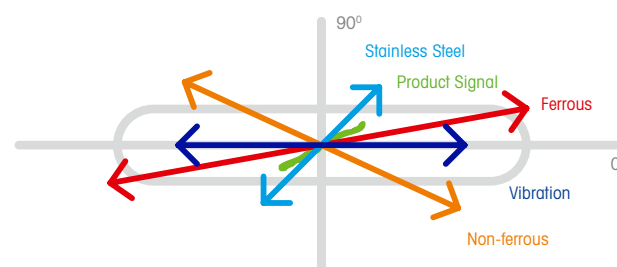
The results documented in Table 7 are achievable when inspecting wet products such as meat, poultry, fish, cheese produce and thawing, semi-frozen products plus those packaged in metallized film.



**Figure 4a:** The active product signal when inspected at two different frequencies (one high, and one low)



**Figure 4b:** The product signal is considerably reduced when METTLER TOLEDO's 3S algorithm is applied in combination with Multi-Simultaneous Frequency technology



**Figure 5:** Using product signal suppression, much smaller pieces of metal are detectable with a sensitivity far closer to those achieved when inspecting dry products

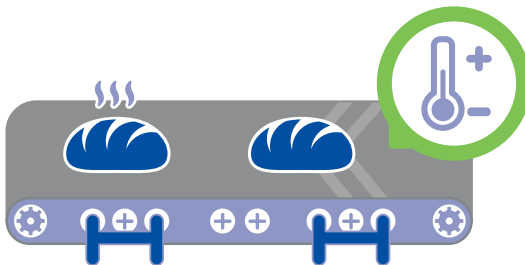
Aperture Size	Ferrous Metal	Non-ferrous Metal (Brass, Copper and Aluminum)	Stainless Steel 316 Grade non-magnetic
<b>350 mm x 50 mm</b>	0.6 to 0.8 mm	0.8 to 1.0 mm	1.0 to 1.2 mm
<b>350 mm x 125 mm</b>	1.0 to 1.2 mm	1.0 to 1.5mm	1.2 to 1.8 mm
<b>350 mm x 200 mm</b>	1.2 to 1.5 mm	1.2 to 1.5 mm	2.0 to 2.5 mm

**Table 7:** Typical sensitivity levels when using Multi-Simultaneous Frequency detection with an intelligent inspection algorithm

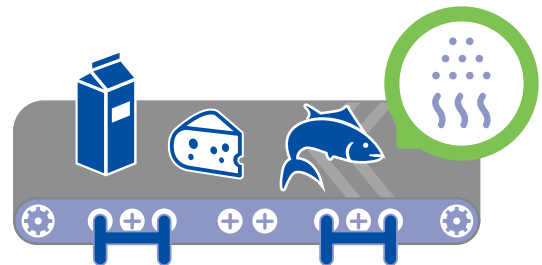
## 4. Overcome Product Effect To Reduce False Reject Rates

Metal detection systems are designed to detect very small metal contaminants, bits of screen wire, metal slivers, swarfs, etc. in products that are often thousands of times larger than the contaminant. It is not surprising that product effect can make it difficult for the detector to distinguish contaminants from product characteristics. This is when the right metal detection technology is essential to overcome product effect.

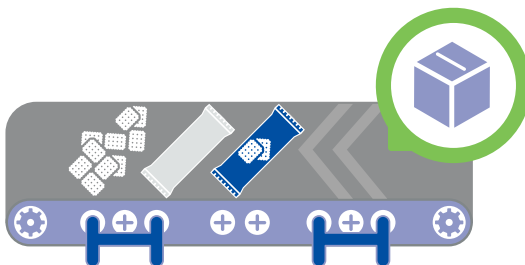
1 Product temperature



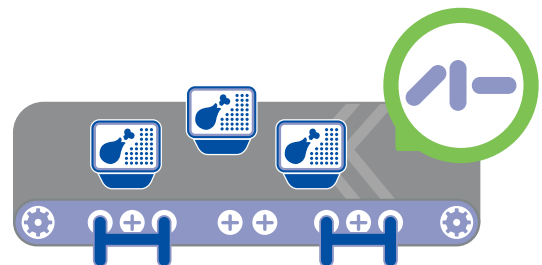
2 Moisture or salt content



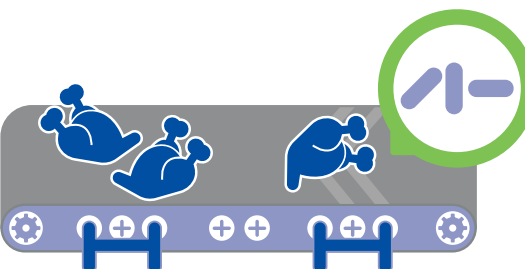
3 Product format



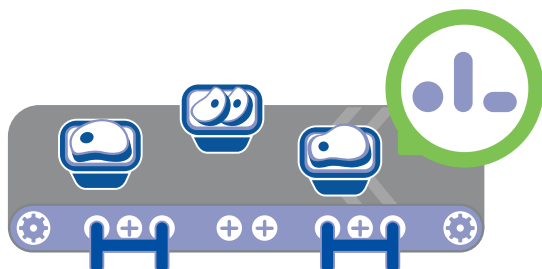
4 Product consistency



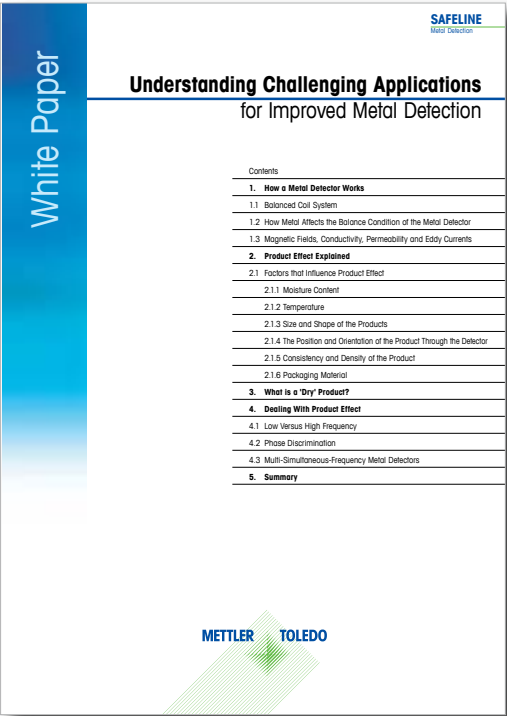
5 Orientation on the production line



6 Product size and shape



For more detailed information on product effect,  
download the whitepaper  
► [Understanding Challenging Applications](#)



Typical food products subject to product effect



## 5. Other Important Considerations To Maximize Performance

In this guide so far, we have focused primarily on understanding sensitivity performance because it is the first consideration you should have when selecting your metal detection system. However, when comparing possible solutions, there are four other key criteria to take into account. These include productivity, environment, compliance and service. The relative importance of each factor will depend upon your business objectives.

### 5.1 Productivity Considerations

If overall equipment effectiveness (OEE) is a key metric for your business, then productivity considerations are essential to ensure you invest in the best solution to meet your needs. This section highlights three key factors that influence productivity performance.

#### 5.1.1 Ease of Operation

Productivity gains can be achieved when metal detection systems are easy to use. Considerations should include ease of use for the operator

- Localization options including operator-specific language and icon-driven menus are key to reduce the risk of errors and improve efficiency
- Step-by-step guidance on essential tasks such as conducting routine performance monitoring tests can also aid productivity
- Product clustering – where multiple products can be run on the same setting – can dramatically reduce downtime between changeovers
- The number of product names and associated settings that can be stored, along with the ease of adding new products or modifying existing settings should also play a part in your decision-making process

#### 5.1.2 Reduce Costly Waste

Falsely rejected food products in manufacturing and processing continues to be costly. Choosing the right metal detection system will pay for itself over its lifetime. By virtually eliminating false rejects, metal detection systems help to minimize unnecessary product waste and the costs associated with investigating potential sources of contamination and documenting the results.

Choosing the right frequency is part of the solution, but equally important is the overall design of the system. Choosing a single supplier solution, designed by experts with in-depth metal detection knowledge, will enable the best possible mechanical and electrical integration for maximum uptime, and help to minimize false rejects.

#### 5.1.3 Minimizing Potential Downtime

Built-in features such as self-check or condition monitoring means you can be notified of any potential drops in metal detector performance before it becomes an issue that results in unplanned downtime. If productivity is a key driver, it is important to consider both the long-term reliability of the proposed solution, but also any features which can mitigate the risk of downtime.

## Case Study

### The Difference The Right Metal Detection Solution Makes



To inspect hot date paste, The Jewel Date Company previously used a conveyORIZED metal detection system that was unstable. This meant they had to freeze the date paste in bulk packages before inspecting it.

"Not only did this waste five days of time and cost a lot in energy use, we also had to move the product between two buildings. Plus, the old metal detector had a lot of false positives," explained said Steve Luicci, Operations Manager at Jewel Date.

The company was able to resolve these issues by switching to a Profile Advantage Pipeline metal detection system from **METTLER TOLEDO Safeline**.



"The Profile Advantage Pipeline has completely transformed our operations. Since it handles hot date paste, we no longer need to freeze it. On top of that, the pipeline structure improves our yield – previously, a reject meant an entire 40-pound [18 kg] bulk package of frozen date paste was lost. Now, the efficiency of the pipeline's diverter valve means only a pound or two of date paste is rejected when the detector is triggered," said Luicci.



Read this and other case studies at:

► [www.mt.com/library](http://www.mt.com/library)

## 5.2 Environment Considerations

Environmental considerations should be taken into account when choosing a metal detector. In particular, its ability to withstand cleaning regimes, remain stable and operate consistently in the production environment long-term are critical.

### 5.2.1 Construction Standards

Having a metal detection system that is fit-for-purpose is essential for maximizing your return on investment. In production environments with harsh washdown procedures, it's important to invest in a solution that can withstand the associated cleaning regimes. Single piece liners, multi-way seal technology and ingress protection up to IP69K are essential to support long term, reliable system performance.

### 5.2.2 Protection From Environmental Interference

Metal detection systems are highly sensitive pieces of equipment. Electro-magnetic interference from surrounding equipment (vibrations, radio waves, etc.) can impact the metal detector's performance and result in high levels of false triggering.

It is important to understand the metal detection system supplier's approach to guarding against noise and vibration interference, and also to ask what they do to ensure the long term stability of the metal detector. Potting methods, construction materials and other mechanical design elements can all play a part in facilitating consistent performance at the expected level.

## 5.3 Compliance Considerations

The first question should always be: can this solution meet the required sensitivity performance standard, so I can achieve my compliance obligations?

However there are some additional considerations to take into account.

### 5.3.1 Documenting and Storing Test Results

All test results should be documented to support compliance. These include any failsafe tests in order to demonstrate that all requirements of the performance monitoring procedures have been executed correctly. Where applicable, follow-up actions should be recorded in the event of failed tests.

The accurate recording of test results is extremely important. In the event of a customer complaint or audit, a manufacturer may need to rely on these records to prove that procedures were correctly followed and that the metal detection systems were functioning correctly to the agreed sensitivity standard. Consider the flexibility a solution offers. Options can range from simple USB data collection to Ethernet connectivity, to advanced software solutions that deliver fully digital record keeping and real-time food safety compliance support.

### 5.3.2 Performance Verification and Monitoring Support

Some metal detection solutions offer advance warning of when a performance monitoring test, or a performance verification is due, or overdue. This can make it easier to meet your compliance obligations. More advanced solutions offer step-by-step guidance on how to execute the monitoring tests, minimizing risk of operator error.

When verification audits of metal detection systems are carried out by trained service engineers, these provide an additional, valuable service. Such audits support the overall metal detection program by confirming that equipment complies with the manufacturer's recommendations, and that the practices employed support the compliance requirements of the applicable industry standard or retailer requirements. Experienced metal detection experts can often spot potential problem areas and suggest solutions before they become apparent to the user. Partnering with a supplier who offers Performance Verification support can make it easier for you to meet your compliance obligations.

### 5.3.3 Operator Training

Operating equipment at optimal performance requires knowledgeable and well-trained operators. It is important for all your production line team to understand the role they play in supporting your company to meet the highest quality and safety standards. Ensuring operators are trained to use the production line equipment correctly is essential to support compliance with industry standards.

By collaborating with the right supplier, you can ensure training options are available to suit the needs of different users. From standard classroom or remote/online training, to individual on-the-job coaching and support. Having a wide range of basic and customizable training events provides the necessary expertise knowledge when operating metal detection equipment.

## 5.4 Service Support Considerations

With the right maintenance support, a well-built metal detection system should last for decades. Partnering with a metal detection system supplier who can offer advice on how to maintain the system correctly, and provide training and support with preventive maintenance is key. Consider also the supplier's ability to provide timely service support in the event your equipment goes down.

- Can they offer 24/7 first line support?
- Do they have technicians located nearby?
- Can they offer virtual support through augmented reality tools to get your line back up and running quickly?

It is also important to explore what additional support the supplier can offer, from training and sharing of expertise, to spare part kits, upgrades to extend the useful life of your equipment and certified test samples to support compliance needs.

## 6. Summary

### Not All Metal Detectors are the Same

**When used as part of a company-wide approach to product safety, a metal detection system is an essential piece of equipment to protect consumers and your brand reputation. The development of metal detection technology continues to improve inspection and detection capabilities and accuracy.**

With this advancement of new technologies, improved sensitivity removes many of the operational compromises that have traditionally affected metal detection processes. When previously, product effect meant a trade-off between the maximum operating frequency and metal detector sensitivity, advanced solutions are now available which deliver very high sensitivity and minimal false rejects.

Choosing the right solution for your application, that is aligned with your performance and budget needs is key.

- In some cases, a solution that delivers stable, reliable performance and high sensitivity may be good enough.
- In other applications, where sensitivity performance and productivity are key drivers, investing in an advanced solution is essential to deliver the highest level of brand protection and can make it easier to meet strict compliance obligations.

By understanding the specific characteristics of the product being inspected, and choosing a fit-for-purpose solution, detection sensitivity can be dramatically increased.

Ideally, metal detection systems should be selected for maximum sensitivity performance. At the same time, they should continuously deliver stable and reliable performance in order to ensure maximum uptime and minimal waste. Without solid foundations in place, such as balance stability, noise and vibration immunity, high performance over time will not be achieved. Investing in cheaper solutions may turn out to be a false economy.

However, just having a metal detection system in place is not enough. It must also be correctly installed, operated and properly maintained for optimal performance. Maintenance should be carried out by the original manufacturer or through in-house engineers trained by the manufacturer. Partnering with a company who have a global service team that can deliver local support is key to maximizing return on investment and ensuring your metal detection system continues to operate reliably.

The right metal detection system has the power to make a positive impact on productivity, product quality and the bottom line.

# Key Considerations

## Checklist for Comparing Solutions

**An outstanding metal detection system supplier should offer a wide range of options to suit your performance and budget needs.**

A checklist is here to help you make the right decision when investing in metal detection systems and applies across the board for food, pharmaceutical and other non-food processors and manufacturers. A competent metal detection system supplier should be chosen with care. Consider the following:

### Sensitivity Performance

- ☐ Does the supplier offer a wide range of products with a choice of frequency options that deliver your required sensitivity performance?
- ☐ Does the supplier offer free product tests to confirm the expected sensitivity performance of the proposed solution for your products?

### Productivity Performance

- ☐ How future-proof is the proposed solution? Is the design modular so it can be upgraded over time?
- ☐ What is the estimated false reject rate?
- ☐ How easy is it to use the system? How much training is required?
- ☐ Does the solution provider have a reputation for long-term reliability?

### Environmental Performance

- ☐ What features does the metal detection system have to ensure it delivers stable, reliable performance even in noisy production environments?
- ☐ What IP rating do you need to align with your cleaning processes?
- ☐ Can the system reliably operate in your factory environment (consider operating temperature and interference from other equipment)?

### Compliance Needs

- ☐ Does the supplier offer installation support and a performance verification package such as IPac to support ongoing compliance with internal and external standards?
- ☐ Does the supplier offer data management software to support rigorous quality control regimes, compliance and reporting needs, such as ProdX?

### Service Support

- ☐ Does your chosen supplier have a reliable service support network with local coverage?
- ☐ Does the supplier offer remote service support options or service care contracts?
- ☐ What ongoing support can the supplier offer in terms of preventive maintenance, or performance verification services?
- ☐ Does the supplier offer options to minimize downtime such as spare part kits?

# Increase Your Understanding of Metal Detector Sensitivity

Are you interested in understanding more about how your metal detector works? Would you like to understand why sensitivity is so important in helping you to reduce the risk of product recalls and to prevent choking hazards due to undetected metal?

METTLER TOLEDO's free guide **"Understanding Sensitivity in Metal Detection"** offers comprehensive guidance for food manufacturers and processors on a range of sensitivity-related metal detection topics. Download it today:

► [www.mt.com/md-guide-sensitivity](http://www.mt.com/md-guide-sensitivity)



**METTLER TOLEDO Group**  
Product Inspection Division  
Local contact: [www.mt.com/contacts](http://www.mt.com/contacts)

Subject to technical changes  
© 08/2021 METTLER TOLEDO. All rights reserved  
PI-MD-EN-eGUIDE-PTFMDS-24082021

[www.mt.com/metaldetection](http://www.mt.com/metaldetection)

For more information